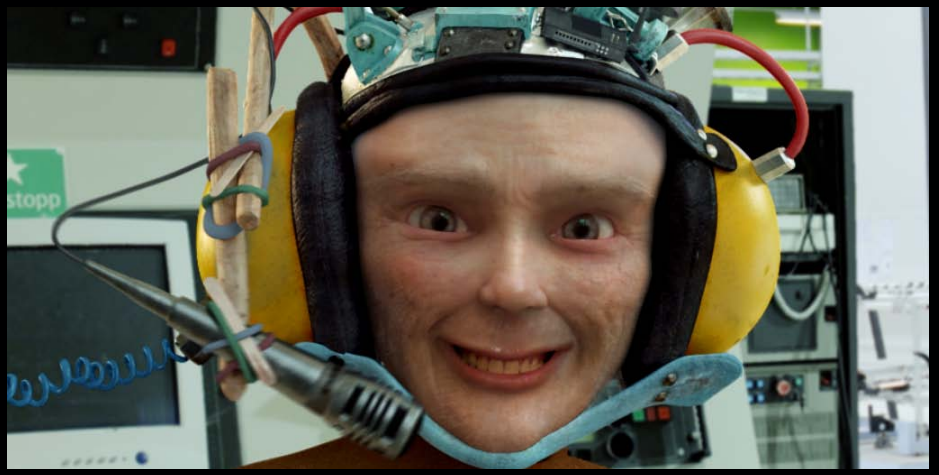
MAXWELL RENDER

MAXWELL RENDER 2.5 USER MANUAL

"Maxwell Render's groundbreaking lighting and shading technology enables our artists to produce better work in less time. Creating shaders with tools based on real-world physics frees our creative process from investing in techniques to fake natural light response. Next Limit also provides the most extensive and qualitative free material library we're aware of. We created and rendered CG elements for all shots in the Vinamilk commercial at double-resolution in one day. Most projects don't move this fast however any job we've used Maxwell on resulted in a net time savings."

Ryan Thompson - Giantsteps



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1 INTRODUCTION

1.01 What is Maxwell Render?

Maxwell Render™ is a rendering engine based on the mathematical equations governing light transport, meaning that all elements, such as emitters, materials and cameras, are derived from physically accurate models. Maxwell Render is unbiased, so no tricks are used to calculate the lighting solution in every pixel of a scene; the result will always be a correct solution, as it would be in the real world. Maxwell Render can fully capture all light interactions between all elements in a scene, and all lighting calculations are performed using spectral information and high dynamic range data.

Due to its very nature, Maxwell Render enables users to create accurate and extremely realistic images. Maxwell Render is a recognized standard in architectural visualization, product design, jewelry, film production, scientific research and other high-end rendering markets, and the leader in render quality.

Maxwell Render is a rendering engine that accepts models and scenes created in 3D or CAD applications. Several of these applications are directly supported through a Maxwell Render plug-in; others can be used in conjunction with Maxwell Render by importing the geometry into Maxwell Studio, a component of the software.

1.02 Why Maxwell Render?

Maxwell Render: easy to use
Maxwell's approach to rendering is based on real-world units and settings. It is not necessary to learn strange new concepts and a long list of render parameters such as "radiosity bounces", "photons" or "final gathering" that are based purely on computer

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graphics terminology, not reality. For example, the settings of the Maxwell Render camera work and adjust just like the settings of a real camera and the strength of the lights in your scene is based on real-world units. Because of this, it is straightforward to create and render scenes, and set-up times are extremely low compared to other renderers.

In addition, Maxwell Render has a truly interactive preview tool, **Maxwell Fire** (Fast Interactive Rendering). **Maxwell Fire** provides instant results while setting up a scene. You can preview your scene's lighting and materials in seconds.

Maxwell Render: unrivalled realism
The technology behind Maxwell Render is physically correct and unbiased, enabling users to create materials, set lights and cameras, and render scenes, all in a hyper realistic manner resulting in images that are indistinguishable from photographs. Maxwell's physically correct creations and data can help architects, designers and VFX supervisors understand what lighting inside or outside a building would look like once realized, or what a final product would look like in production.

Maxwell Render: good value
A Maxwell Render license not only gives you access to the most realistic renderer on the market, you also get free plug-ins to a wide range of popular 3D and CAD applications, including Maya, Cinema4D, Rhino and SketchUp, so you can use Maxwell Render while staying in the comfortable environment of the modeling software you are already familiar with. For a complete list of available plug-ins go to section 3.01, Plug-ins. You also get access to an online library of over 3900 free and ready-to-use materials, plus other resources like textures, skies, free tutorials and community support.

Maxwell Render: a complete package
The Maxwell Render software package provides a complete solution, with a rendering engine, a fully interactive preview tool (Maxwell Fire), a material editor, an editing application, and a series of free plug-ins all in one. The application offers a range of features needed to prepare, edit and render perfect images in a comfortable and straightforward fashion, such as Multilight, Sub-surface scattering, Stacked materials and Displacement. Please see below for a complete list of features in Maxwell Render.

Maxwell Render: something for everyone
Maxwell Render is the best solution for users with all kinds of requirements, needs and backgrounds. For instance, Maxwell Render's physically correct simulation helps architects and designers to envisage how natural and artificial light will affect their creations. Automotive-, jewelry- and product designers can work with the thousands of free, ready-to-use shaders that come with the software. And Maxwell's realistic lighting enables them to create images that look like photographs, saving the high expenses of actual studio shoots and giving a clear idea of what the final product will look like. Artists in the VFX and film industry will find that Maxwell Render's robust and easy to use network system provides the speed and control they need in their complex pipelines and the demanding environments they work in.

1.03 Complete features list

For a complete overview of all features available in Maxwell Render, please see:

http://www.maxwellrender.com/pdf/featureslist-v2.pdf

For an overview of the new features and improvements in the latest version of Maxwell Render, please see:

http://www.maxwellrender.com/pdf/whatsnew-v2.1.pdf

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2 THE MAXWELL REALITY. UNDERSTANDING MAXWELL'S APPROACH TO RENDERING

While Maxwell Render is uncomplicated and straightforward, it does make use of some concepts and functions that may be new or different to you. They account for Maxwell Render's superb quality and realism. It is important to understand these concepts and how they differ from more commonly used notions before you start working with Maxwell Render. Note that these functions are explained in further detail later on in the manual.

2.01 Lighting in Maxwell Render

Light sources in Maxwell Render™ are defined by spectral characteristics and a light source usually possesses a lot of information about the intensity of emission at any of the possible wave lengths.

Maxwell Render does not use abstract lights typically used in traditional 3D applications (distant, point, omni, spotlights). Instead, Maxwell Render uses actual geometry with emitting materials. This approach to simulate lights emulates what happens in the real world and mimics real-world lights, producing a high degree of realism, outputting smooth shadows, providing a natural light distribution in your scene, and increasing the overall quality of your image. Maxwell Render can handle large numbers of lights in a scene without the performance loss sometimes experienced in other applications.

Lights in Maxwell Render™ are created applying an emitter material to an object. You can adjust the color and intensity of the emitter using everyday terms like watts or efficacy, or you can look into more advanced definitions using lumens, lux, Kelvin degrees, and RGB. If you are new to Maxwell Render, it is best to start by selecting an emitter from the Presets dropdown.

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2.02 Environment

Maxwell Render provides a complete Physical Sky system with a sophisticated atmosphere model that reproduces skylight conditions at different hours, dates, and locations. The Physical Sky system is a simple way to obtain extremely accurate lighting in your scenes.

The atmosphere parameters allow users to customize the look of the sky and the resulting light in the scene, ranging from common Earth values to exaggerated fantasy skies. Users can also create presets of the sky settings to quickly load a new sky or share their presets with other users. It's also possible to save the current sky as an HDR map.

2.03 Interactive workflow

With Maxwell Render you will get an awesome interactive workflow, saving a lot of your time as you don't need to re-launch the render for every parameter you adjust.

First: Maxwell Render allows you to re-expose your image interactively during the render process. Multilight enables you to adjust the intensity of all the individual or grouped lights in your scene during or after the rendering process to get the results you are looking for. It is also possible to resume a render after it has finished rendering.

The exposure is the level of brightness of the final image. With most conventional rendering engines, if your image is too dark, you have to re-render again. In Maxwell Render, you can adjust the exposure (adjust the level of brightness) during the render, or even after the render has finished. Moreover, if you enable Multilight, you can adjust the intensity of the different lights in your scene separately even after the render has finished.

Second: Maxwell Render includes a truly interactive render preview, **Maxwell Fire** (which stands for Fast Interactive Rendering), which allows you to preview your scene in a fully interactive window (in Studio and in those plug-ins where Maxwell Fire is available), displaying a great quality preview render of your scene in seconds. This makes it much faster and easier to adjust your materials, adjust the environment conditions, set up the camera parameters or your emitter's intensity and color, and see the results in real time. Again, Maxwell Render is a huge time saver in your pipeline.

2.04 Cameras

Cameras in Maxwell Render™ operate completely different from those in other render engines. Traditionally, most render engines use a pinhole camera. This type of camera simulates a tiny hole that allows light rays coming from the scene to reach the viewing surface. Instead, Maxwell Render™ simulates a real camera with the associated lens set, diaphragm aperture, diaphragm blades and various other settings. By using this type of camera model Maxwell Render™ can automatically simulate depth of field or aperture diffraction.
Along similar lines, motion blur in Maxwell Render™ is not produced as a post-process. Maxwell Render™ considers the moving objects to have random positions along their trajectories during the camera shutter speed time. This creates a natural and realistic motion blur.

Maxwell Render's SimuLens™ system allows you to simulate the shape of the diaphragm, creating realistic lens diffraction effects. It is also possible to simulate the scattering of light inside a lens system, an effect typically called "bloom".

2.05 Materials

Maxwell Render™ materials – called MXM – are defined in a physically correct manner by their BSDF functions (Bidirectional Scattering Distribution Function), making it possible to build up different layers of materials in the same object, like other BSDF or SSS (Sub Surface Scattering) effects. Thin coatings are also available for very subtle and realistic effects such as thin film interference effects for the multicolored look of a thin layer of oil in water, or soap bubbles.

Maxwell Render™ materials are not only physically correct but also very flexible and versatile.

Bump/ Normal Mapping, Displacement, Dispersion of light and Emitting properties are other characteristics available in the Maxwell material system.

With Maxwell Render 2 and its new stacked layers system, it is possible to create sophisticated materials easily. Materials can now be stacked in a layered way, so you can

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mimic many surfaces that are composed of different materials one over another.
Maxwell materials are based on physical properties and therefore very easy to use once understood properly. To help users to understand and use the Maxwell materials, we have created the Maxwell Resources webpage, were you can freely download thousands of photorealistic materials ready to use in your own projects.

We also provide Wizards to guide the user in material creation.

2.06 Learning curve

Maxwell Render™ is based on how light interacts with objects and materials in the real world, so the concepts behind it are easy and intuitive to learn. You don't have to learn many parameters with strange terminology that have no equivalent in the real world - you work more like a photographer.
You set up your lights using real world values, you adjust the camera using real camera parameters and let Maxwell Render handle the rest. This intuitive workflow is also flexible enough to allow for in-depth technical experiments, reviews or renders, if that is what you're looking for.

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3 USING MAXWELL RENDER

Maxwell Render™ provides two alternative workflows:

1. **Through plug-ins.** This method allows you to use Maxwell Render with your favorite 3D/ CAD package, through one of the freely available plug-ins. The Plug-ins create a .MXS (Maxwell scene file) which is then sent to Maxwell Render. This is the recommended workflow.
2. **Through Studio.** It is possible to import geometry saved in one of the supported formats into Studio, where you can create/ edit/ assign materials, and set up lights and cameras. Studio creates a .MXS file which is then sent to Maxwell Render for rendering.

3.01 Plug-ins

3.01.01 Scene Exporter Plug-ins

Stay in the comfortable environment of your favorite 3D/ CAD application and use the corresponding Maxwell plug-in to connect to Maxwell Render and take advantage of the software's capabilities. The advanced level of integration makes it unnecessary to get in-depth Maxwell Render training, saving you time and money.

We have created a range of plug-ins to connect Maxwell Render to the most popular 3D and CAD applications in the industry:

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Platform	Version	Win32	Win64	Mac OSX	Linux
3dS Max (with Maxwell Fire)	7				
	8				
	9				
	2008				
	2009				
	2010				
	2011				
Autodesk VIZ	06				
	07				
	08				
Maya (with Maxwell Fire)	8.5				
	2008				
	2009				
	2010				
	2011				
LightWave	8.x				
	9.x			(9.3 UB)	
Cinema4D	R9.6 and up				
Rhinoceros (with Maxwell Fire)	v4 SR5				
	v5 WIP				
Softimage XSi	6.01				
	7.01				
	2010				
	2011				

Platform	Version	Win32	Win64	Mac OSX	Linux
SolidWorks (with Maxwell Fire)	2007 (s.p. 3.1)				
	2008				
	2009				
	2010				
	2011				
ArchiCAD	AC 12				
	AC 13				
	AC 14				
Form•Z	6.1 and up (6.7 recommended)			(UB)	
SketchUp	6				
	7				
	8				
Modo	302				
	401				

* 3ds Max 2010 and 2011 plug-in is valid for 3ds Max Design too.

	Maxwell Render plug-in is available
	3D application on this o/s exists but we do not yet have a plug-in
	Not applicable – 3D application on this o/s does not exist
x86	A 32 bit version of this plug-in is available and is fully functional on Win 64

Third party:

- Allplan
- solidThinking

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a. Downloading and/or updating the plug-in

Depending on the specific host application, some plug-ins provide the user with automatic updates. If you need to manually update your plug-in or if you are a new user and need to download it, you can do so through our customer download area. The link to the customer download area is provided in your license email, sent to you when you first purchased the software.

b. Installing the plug-in

After installing Maxwell Render, you still need to download and install your plug-in separately. The plug-in is not included with the main Maxwell Render installation. Select the plug-in you want to install from the download page, and the folder where your 3D/ CAD application is installed. Then run the installation and follow the steps.

c. Exploring the plug-in

Open your 3D/ CAD application and make sure that the Maxwell plug-in is successfully installed. You will find tools to control the Maxwell rendering process in your Render Panel, Camera Settings Window, Material Editor, and so on. The location and position of the Maxwell tools depend on the structure of each individual 3D/ CAD application user interface.

Further information about the plug-ins and how to use them can be found in the installation package of each plug-in, available from the customer download site mentioned in your license email. It is highly recommended to carefully read the manual of your plug-in before starting to use it.

3.01.02 MXI Importer Plug-ins for Postprocduction

Maxwell Render provides a great level of integration between the rendering engine and the postproduction packages. This allows you to import your MXI render files (including all the independent buffers contained inside) directly into your postproduction platform providing you with a comfortable and powerful workflow.

We have created plug-ins to connect Maxwell Render with:

Platform	Version	Win32	Win64	Mac OSX	Linux
Nuke	5				
	6				
Photoshop	CS3				
	CS4				
	CS5				
After Effects	CS3				
	CS4				
	CS5				

Maxwell Render plug-in is available

3D application on this o/s exists but we do not yet have a plug-in

Not applicable – 3D application on this o/s does not exist

3.02 Studio

The Maxwell Render software package comes with a complete and independent GUI application called Studio. It is possible to import geometry and .MXS files into Studio, where you can compose your scene, set up lights, cameras, and environment parameters, create and apply materials, and send to render. Studio accepts geometry in the following formats:

File formats supported in Maxwell Studio												
OBJ	STL	LWO	PLY	XC2	DXF	3DS	XML	NFF	FBX	Collada	DEM	SDTS

The Studio workflow is mostly recommended to people working with 3D/ CAD applications that do not have a plug-in to directly connect them to Maxwell Render. Even if there is a

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plug-in available for your application, you can still make use of Studio by importing a scene or geometry, and making further adjustments to your materials/ cameras/ lights. Or you can merge different .MXS files together into one scene.

3.03 Maxwell Fire: Fast Interactive Rendering

Maxwell Fire is an interactive tool which provides instant results while setting up a scene. You can preview scene lighting and materials in seconds. And more importantly, Maxwell Fire is:

- Compatible with all Maxwell Render materials and features
- A truly interactive workflow: integrated in plug-ins and Maxwell Studio
- Entirely CPU based: no additional hardware required
- No extra cost: it is not a separate add-on application, and is a free update for Maxwell Render 2.x clients.

The first roll-out of Maxwell Fire is in Maxwell Studio, and in certain plug-ins: currently Maya, 3dS Max and Rhinoceros. Other plug-ins will see the addition of Maxwell Fire in the near future, subject to SDK limitations.

Maxwell Fire represents a new and innovative solution to improve the workflow and interaction between user and render output at both pre- and post-processing stages.

Preview scene lighting and materials in seconds
Maxwell Fire is an interactive preview tool that will significantly speed-up your workflow by allowing you to see scene changes instantly through a floating window inside your normal user interface.

Instead of constantly doing test renders and moving your camera or objects to check where emitter reflections fall on a surface or see how the bumps and color look in your scene, with Maxwell Fire you can get real-time feedback when editing a material or moving your camera and/or objects in the scene.

Compatible with all Maxwell Render materials and features
Maxwell Fire is not a separate product: it is a workflow enabler inside Maxwell Render which has full compatibility of materials and objects, and with the final high quality Maxwell Render engine.

Our goal when creating Maxwell Fire was not to cripple your workflow by forcing you to abandon certain material types and features if you want to instantly preview your scenes. Rather, Maxwell Fire supports all Maxwell Render materials (including subsurface scattering, displacement, complex IOR, emitters) and all Maxwell Render features (including instances, depth of field, motion blur, RealFlow Renderkit).

Truly interactive workflow
Maxwell Fire is a truly interactive workflow, available in both standalone Maxwell Studio, and integrated in plug-ins for those that wish to continue to work inside their host 3D application (currently Maya, 3DSMax and Rhinoceros, but the rest will come in the the following months).

Another major advantage of Maxwell Fire over other interactive rendering solutions is that you can manipulate the geometry in your scenes. We realize most users wish to change/translate the scene geometry often, or move an emitter to change the lighting etc. With Maxwell Fire integrated into Maxwell Studio and plug-ins, you can work within a familiar environment and instantly see any changes you make not only to the camera and materials, but also the scene geometry. There is no need to re-export/re-import your scene every time your geometry changes, which could hardly be called an interactive workflow.

Entirely CPU based
Instead of using GPU based algorithms, which force you to buy expensive graphics cards to achieve the desired results, Maxwell Fire is CPU based, and no special hardware is needed.

Maxwell Fire does not require you to purchase additional or specific hardware to get maximum performance. Maxwell Fire works on standard CPUs within your existing machine; it does not require specific hardware or GPU technology.

While GPU hardware has become more capable of handling some of the calculations a complex render engine requires, they are still not ready to efficiently accommodate all physically accurate Maxwell Render features.

No extra cost
Maxwell Fire is included for free in Maxwell Render. It is not a separate application and it

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does not require a special Maxwell scene file to work.

Maxwell Fire is a free update for existing users of Maxwell Render 2.5 or above and will be free inside Maxwell Render for new clients.

Educational Users also benefit
Maxwell Fire will also be included as a free update to Educational versions of Maxwell Render v2: anybody holding educational licenses of Maxwell Render 2 will get full functionality of Maxwell Fire.

Free Demo version of Maxwell Render also includes Maxwell Fire
The free demo version of Maxwell Render 2.5 and relevant plug-ins will also include Maxwell Fire. So anybody wanting to road-test Maxwell Render will also be able to take advantage of this awesome interactive technology. This also means anyone wanting to test Maxwell Fire inside their plug-in and/or Maxwell Studio will be able to check it out for free.

Necessary resolution restriction
Like the free Demo version of Maxwell Render itself, Maxwell Fire inside the free demo version has its rendering resolution limited to 720x576 pixels. You can adjust the rendering resolution in a quality scale, taking values from 1 to 5, meaning that you can easily specify the quality/speed of your interactive view.

3.04 Command Line

Maxwell Render can also be launched from the command line, without displaying the Maxwell GUI. This can be useful for automating certain render tasks, although the new scripting capabilities in Maxwell Render version 2 (and further extended in version 2.5) offer much greater control and functions to automate jobs. Please see the in-depth Command Line description in Appendix III.

3.05 Network rendering

High-end projects often need extra computing power. The Maxwell Render™ Network system allows jobs to be sent individually to each machine on the net, rendering animations or single frames. It is also possible to let all machines render the same frame and merge the images that have been created at the end of the rendering process. Other useful functions include grouping nodes for exclusive assignment or displaying an image that is being rendered by a specific node.

Maxwell Render 2 brings a completely new Network system which is more stable, more robust, and easier to configure, with central control over the entire farm.

3.06 The Demo version

A free Demo version of Maxwell Render is available from the official Maxwell Render website at:

http://www.maxwellrender.com/mw2_demo.php

The demo will enable you to become familiar with the software, see if it fits in your workflow, understand how it would benefit your work, and generally make sure Maxwell Render is exactly what you are looking for. The demo version has a 30 day time limit, and a few other necessary restrictions:

- Watermarked render
- Maximum render size of 800 x 600 pixels
- Network rendering not available
- Preview Rendering in viewport in Maxwell Studio not available
- A limit of 5 editable lights in your scene when using Multilight

The demo will provide you access to the main software, the plug-ins, manuals, materials and other resources.

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3.07 Installing Maxwell Render

Windows

Run the installation file and follow the installation procedure.
The Maxwell Render V2 executable files will be added to the system path.
Two user environment variables named MAXWELL2_ROOT and MAXWELL2_MATERIALS_DATABASE pointing to the installation folder will be added.
If these variables do not exist or are not created properly, the application will fail.

> ☑ *Important: It is strongly recommended to install Maxwell using administrator permissions.*

Mac OSX

Open the disk image and drag the Maxwell 2 folder to your Applications Directory. Install the plug-in of your 3D platform from the plug-ins folder.

> ☑ *Important: When launching Maxwell Render from a plug-in, it will locate Maxwell by the OSX-preferred application for MXS files. You can check this by getting information from an MXS file. If you have more than one version of Maxwell Render installed on your system, make sure it has selected the correct one.*

Linux

Get maxwell-2.5-Linux64.tar.gz.
Uncompress it and untar it inside the folder of your choice, preferably /opt or /opt/local

```
gzip -d maxwell-2.5-Linux64.tar.gz
tar xvf maxwell-2.5-Linux64.tar
```

This will create a folder called maxwell64-2.5 with everything you need to run Maxwell Render.

If you use bash shell, add the this line to your .bash_profile:

```
export MAXWELL2_ROOT=/opt/local/maxwell-2.5
```

If you use tcsh or an equivalent C-shell, add this to .cshrc or .tcshrc:

```
setenv MAXWELL2_ROOT /opt/local/maxwell-2.5
```

In the above lines, change "/opt/local/maxwell-2.5" to match your Maxwell installation folder.
If you wish, append $MAXWELL2_ROOT to your $PATH so Maxwell Render can be run from anywhere.

3.08 Licensing Maxwell Render

The Maxwell license file is a license.txt file containing information about your license, and it was sent to you in an email from the Next Limit Sales department when you purchased Maxwell Render.

After installing Maxwell Render, open Maxwell.exe (Win) or Maxwell.app (Mac) and go to Help> License Info. A pop-up screen will appear. Click on the "Add" button in the lower left corner, and copy your license key in the screen, then click "Save". Make sure to not change the license text in any way. You have now licensed the software!
Once you have licensed the software, your license key will be saved in your Maxwell user folder, for example in My Documents/Maxwell. If you are not sure where your license key is stored, then please open Maxwell.exe (Win) or Maxwell.app (Mac). The console window will display where your license key is located, stating "License found in.....".

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3.09 Minimum system requirements

The minimum system requirements for Maxwell Render are as follows:

Windows (32 and 64)
- Windows XP, Windows Vista, or Windows Server 2008
- 2 GHz Intel® Pentium®4 processor, AMD Athlon 64 or better
- 1GB RAM minimum. 4 GB of RAM memory is highly recommended
- 400 MB available hard disk space for installation
- Accelerated OpenGL drivers
- 3 button mouse recommended

Linux 64
- x86_64 distribution with a 2.6 Kernel and glibc 2.5
- 2 GHz Intel® Core®2, AMD Athlon 64 or better
- 1 GB RAM minimum. 4 GB of RAM memory is highly recommended
- X server with accelerated OpenGL drivers
- 300 MB available hard disk space for installation
- 3 button mouse recommended

Macintosh (32 and 64)
- Mac OSX 10.5 and up
- PPC or Intel® CPU. Intel® is strongly recommended
- 1 GB RAM minimum. 4 GB of RAM memory is highly recommended
- 400 MB available hard disk space for installation
- 3 button mouse recommended

* PPC systems only allow Maxwell Render 32Bits

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4 GETTING STARTED

Now that you know what Maxwell Render is, let's start using it.

To help you take your first steps in Maxwell Render, we have created a series of Getting Started video tutorials, covering the basic concepts and main functions you need to set up and start rendering a scene. Specific videos are available for all supported plug-ins so that you can learn the Maxwell basics without having to leave the familiar environment of your own 3D/ CAD application.

The videos are available from the THINK! website at http://think.maxwellrender.com

We have also created a standard scene to make it easier for you to follow the videos. The scene is also available for all 3D and CAD applications compatible with Maxwell Render.

The sample scene can be downloaded from the THINK! website.

If you are using Maxwell Render with a plug-in for one of the supported 3D/ CAD applications, then please check your specific plug-in manual to understand where to find particular Maxwell Render buttons and settings, as they can differ slightly depending on your plug-in.

The concepts covered in the videos are also explained in further depth in the following chapters.

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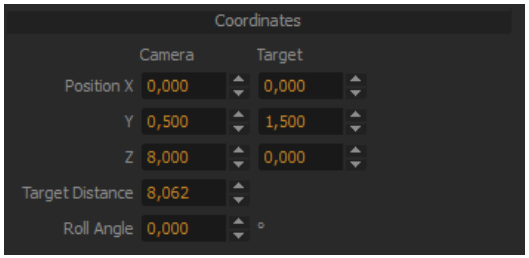
5 CAMERAS

Note: In order to unify the look of this manual, the screenshots in this chapter were taken from the Studio interface, so they may have a slightly different look or position in other 3D platforms.

These are the main parameters you should take into consideration:

5.01 Position



F.01 Position

- **Camera Position:** X, Y, Z world coordinates of the location of the camera.
- **Target:** X, Y, Z world coordinates of the target of the camera.
- **Focal Distance:** Distance from the camera to the camera target. The camera target represents the point where your render will be in perfect focus.
- **Roll Angle:** Rolling angle of the camera (in degrees).

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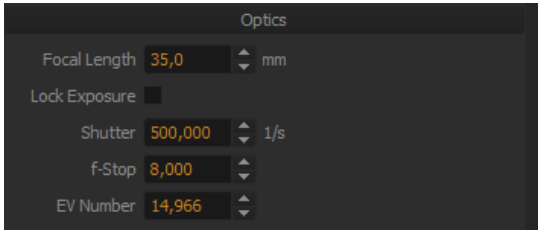
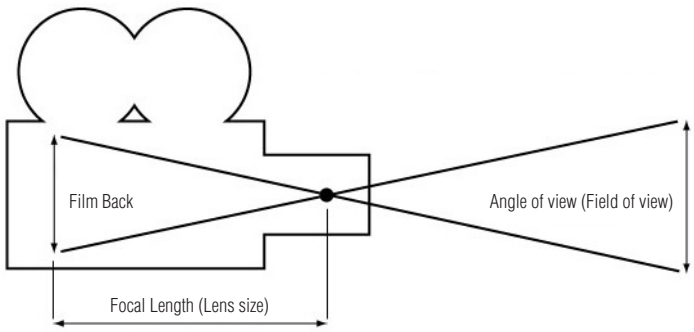
5.02 Optics



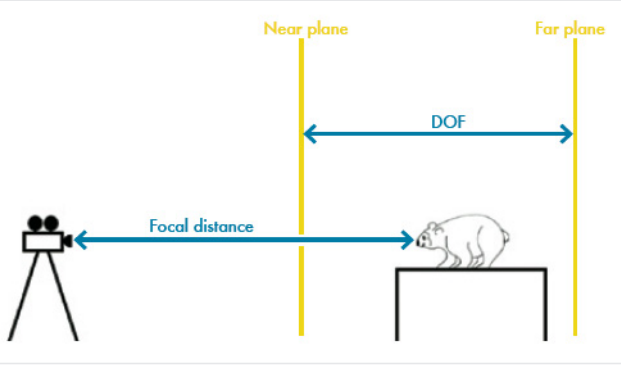
F.01 Optics

- **Focal Length (mm):** The focal length of the lens. Focal length is a measure of how strong an optical system converges or diverges light. The effect of this parameter is to "zoom" in on a portion of your scene as the focal length increases (from 100mm and up it would be considered a "Tele-Photo" lens which acts more like binoculars), or reveal more of your scene as the focal length decreases (20mm is considered a "Wide-Angle" lens because it has a wide viewing angle – it can see more of your scene). This parameter also controls the DOF (depth of field) of the render. A wide-angle setting means most of your scene will be in focus (a wide DOF), while a larger focal length like 80mm means a smaller portion of your scene will be in focus (a narrow DOF).
- **Shutter (1/s):** In photography, a shutter is a device that allows light to pass for a determined period of time to expose photographic film to the right amount of light to create an image. The shutter speed or the time light has to reach the film is specified in 1/n of a second. A higher number means the light has less time to reach the film.
- **f-Stop:** Controls the aperture of the lens. An important concept in optics, f-Stop represents the diameter of the entrance pupil in terms of the effective focal length of the lens. F-Stop is the quantitative measure of lens speed in photography. A smaller f-Stop means the aperture (diaphragm) of the lens is more open, and higher f-Stop values mean the aperture is more closed. This has the effect of letting more or less light pass through the lens to reach the film. It also affects the DOF of your render. The smaller the f-Stop, the smaller the DOF, so only a small area of the image will be in focus.
- **EV number:** This parameter computes the Exposure Value from the Shutter and f-Stop values. You can also lock the exposure level in your render by using the Lock Exposure checkbox, which will allow you to change any of the parameters while keeping the same exposure level.

For a deeper explantion of these camera concepts please consult Cameras and Camera Parameters secction.



F.02 Camera concepts



F.03 The camera is pointing to the area of interest

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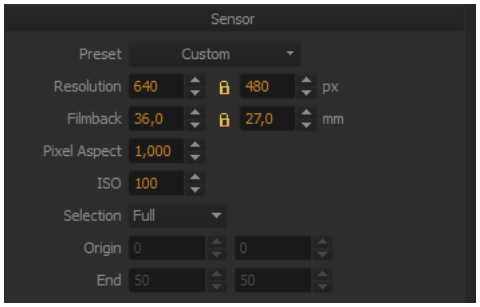
5.03 Sensor

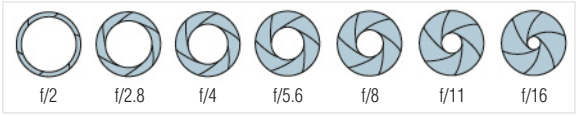
- **Resolution:** The horizontal and vertical (width and height) resolution of the image in pixels.
- **Film Back:** Camera film/ sensor width in mm.
- **Pixel aspect:** Width–height proportion of the pixels. Useful when the rendering output will be displayed on devices which have non-square pixels, such as television sets.
- **ISO:** The measure of a photographic film's sensitivity to light. The lower the ISO, the lower the film's sensitivity, requiring a longer exposure to light or stronger emitters. A film with a high ISO only needs a short exposure to light. This parameter can also be set interactively while rendering. Raising the ISO will not add noise to the render – this belief comes from an association with higher ISO-rated photographic film.
- **Selection:** Specify whether you want to render the full frame at the desired resolution, render a particular region (defined by the Origin and End numeric fields), or blow up a region (defined by the Origin and End numeric fields) at the desired resolution. You can also draw the desired region using the marquee icon.



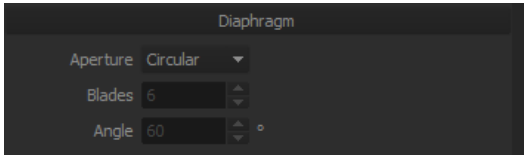
F.01 Film Back

Note: Rendering regions is now also possible through scripting and command line. The command line argument is -region:type,x1,y1,x2,y2 where type is "full", "region" or "blowup".

5.04 Diaphragm



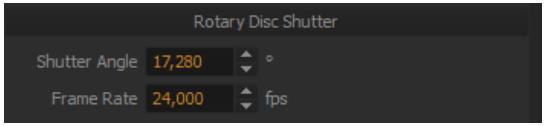
F.01 Diaphragms



F.02 Diaphragm

- **Aperture:** Choose Circular or Polygonal. This controls the shape of the "bokeh" effect caused by bright spots in the parts of the render that are out of focus.
- **Blades:** Number of blades (for Polygonal diaphragm).
- **Angle:** Rotation angle of aperture opening (for Polygonal diaphragm).

5.05 Rotary Disk Shutter



F.01 Rotary Disk Shutter

- **Shutter Angle (degrees):** This option allows you to control the amount of motion blur in an image in animations. For still camera photography (Maxwell Render's default), the amount of motion blur in an image is controlled by the Shutter Speed parameter. The lower the Shutter Speed is, the longer the shutter is open, and the

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more pronounced the motion blur will be.
However, for animations – when replicating a film camera – the shutter speed is generally fixed to a certain speed, usually 24 frames per second (1/24). Since film cameras cannot control the amount of motion blur by changing the shutter speed, they instead have a rotating disc with an adjustable pie-shaped cut-out on it, which controls how long each frame is exposed. The width of the cut-out is called Shutter Angle, and is expressed in degrees. Fully open (180 degrees) will yield the maximum amount of motion blur, while a very narrow setting (say, 15 degrees) will produce very subtle motion blur. This feature automatically translates your usual ISO/ Shutter speed settings in combination with the Shutter Angle, so your animation exposure will match your still image exposure, while producing the proper amount of motion blur.

Maxwell Shutter (exposure) = FPS (frames per second) * 360 / Shutter Angle.
Shutter Angle = FPS * 360 / Maxwell Shutter (exposure).
% of motion blur = Shutter Angle * 100 / 360.

- **Frame Rate (fps):** Frames per second in the rendering camera.

5.06 Shift Lenses

- **Offset (%):** This parameter allows you to offset the lens position horizontally and vertically. It can be useful to correct geometric perspective distortion.

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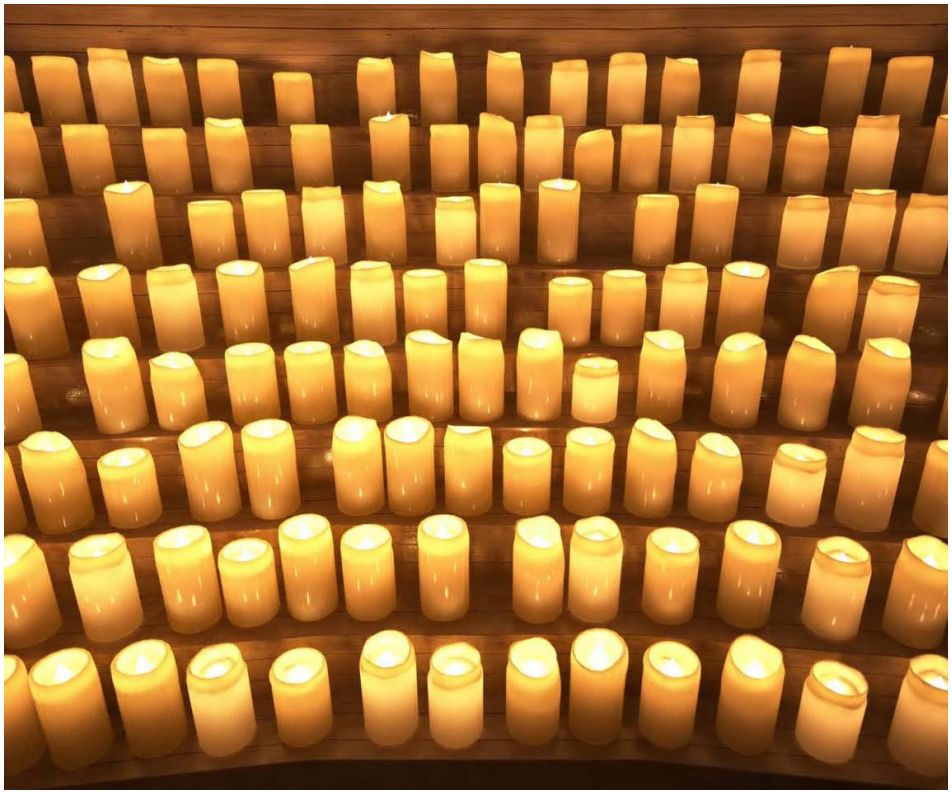
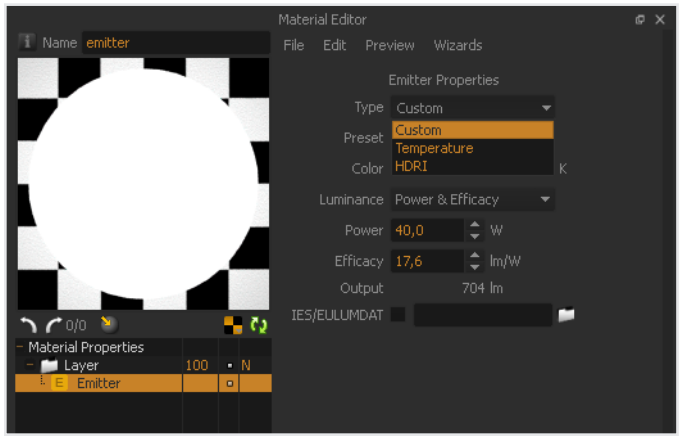


6 LIGHTING WITH EMITTERS

Note: In order to unify the look of this manual, the screenshots in this chapter were taken from the Studio interface, so they may have a slightly different look or position in other 3D platforms.

Emitters in Maxwell Render are part of the material system. An emitter material should be applied to the geometry you want to emit light from. The emitter geometry needs an actual surface area; it is not possible to apply an emitter material to a Null object for example.

Create a geometry (a bulb, a tube, or just a simple plane), apply a Maxwell material and add Emitter properties to it. You now have an object that is lighting your scene. To optimize your scene, try to use low-polygon geometry for your emitters. A single polygon plane will do in most cases.



F.01 Emitter types

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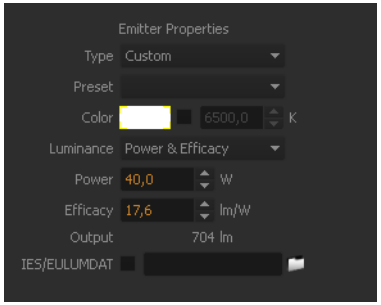
Emitter Materials are defined in a very intuitive way, using real world values like watts or efficacy. Your emitter can be defined in three different ways:

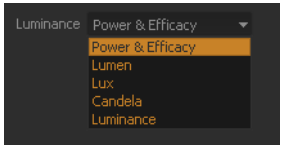
- **Custom:** This option allows you to set the Color and the Intensity of your light separately. Color can be set in RBG, HSV or XYZ scales, or correlated to a Kelvin value. Intensity (or Luminance) can be set in a number of different ways (see next section). You can also specify an IES/ Eulumdat file to light your scene, using measured lighting data for different lighting fixtures. These files are provided by many major lighting manufacturers.
- **Temperature:** In Kelvin degrees. In the real world, the temperature of the light source determines both the color and its intensity. Colder temperatures (near 3000ºK) emit reddish, low-intensity light, while higher temperatures (near 9000ºK) emit blue, bright light. This control will allow you to adjust both the intensity and the color of your emitter with one single slider.
- **HDR Image:** You can use a high dynamic range image which will emit light from the emitter surface, using images in HDR, EXR or MXI formats.

6.01 Custom



F.01 Custom

- **Color:** This parameter refers to the color of the light emitted. There are two ways to specify the color:
  a. **Using the Color Picker:** Clicking on the colored square allows the user to choose a color in the Maxwell Render color picker.
  b. **Correlated Color at Kelvin Temperature (ºK):** This options lets you choose the color that would correspond to an emission in Kelvin degrees. Please note that choosing this option will not make any changes in intensity, just color. Low Kelvin temperatures are reddish, 6500ºK is considered white, and higher values will produce a bluish light.
- **Luminance:** Specifies the intensity of the light. There are several options to specify luminance, like Power & Efficacy, Lumens, Lux, Candelas and Luminance:



F. 01 Luminance types

  a. **Power and Efficacy:** These options allow you to specify how much electricity a light source consumes (Watts) and how efficiently it converts that electricity into visible light (Efficacy). The efficacy number specifies how many lumens are emitted per watt. For example, a common 40W incandescent light bulb will have a rather low efficacy of 12.6 lumens/ watt. This information is usually supplied by the bulb manufacturers. A more efficient, energy saving bulb which is also rated at 40W will have an efficacy of perhaps 17.3 lumens/ watt, so for the same amount of energy consumed, it will emit more light. The watts/ efficacy way of specifying an emitter's intensity is useful if you would like to mimic common light sources, where the manufacturer provides the watt rating and the efficacy rating. In the "Output" row you can see how many Lumens a particular watt/ efficacy setting will create.
  b. **Luminous power:** Lumens (lm) is the SI (International System of Units) unit for luminous flux. It is a common way to specify how much light is emitted. Light manufacturers usually supply this data.
  c. **Illuminance:** Lux (lum/m^2). Lux is the unit for specifying illuminance. It is defined as one lumen per square meter. This is a useful setting when you would like to increase or decrease the size of your emitter, and have it emit more or less light. If you use lumens and scale up your emitter, the same amount of lumens are emitted but from a larger area, giving the impression that the emitter is weaker. If you use Lux however, the amount of lumens increases/ decreases with the scale of your emitting surface.

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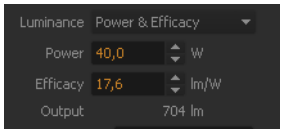
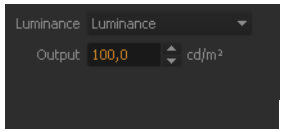
d. Luminous Intensity: Candela (cd). Candela is considered the SI unit for luminous intensity; the power of the light emitted in a certain direction.

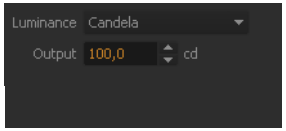
e. Luminance: Nit (cd/m^2). One "Nit" is one candela per square meter.



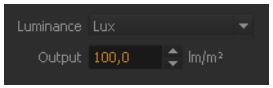
F.01 Power and efficacy



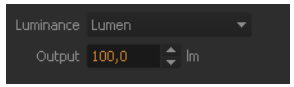
F.02 Luminous power



F.03 Illuminance

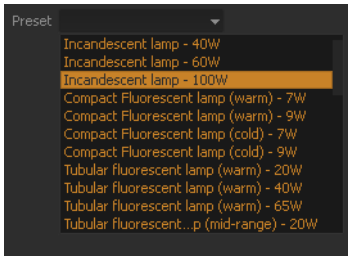


F.04 Luminous intensity



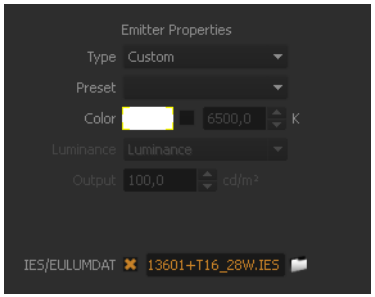
F.05 Luminance

- **Preset:** Maxwell Render™ provides some emitter presets of standard type light sources. Please note these presets will change the color as well as the intensity of your emitters.


Preset
Incandescent lamp - 40W
Incandescent lamp - 60W
Incandescent lamp - 100W
Compact Fluorescent lamp (warm) - 7W
Compact Fluorescent lamp (warm) - 9W
Compact Fluorescent lamp (cold) - 7W
Compact Fluorescent lamp (cold) - 9W
Tubular Fluorescent lamp (warm) - 20W
Tubular Fluorescent lamp (warm) - 40W
Tubular Fluorescent lamp (warm) - 65W
Tubular Fluorescent...p (mid-range) - 20W

F.06 Presets

- **IES/EULUMDAT:** Lets you load an .IES or .EULUMDAT file that specifies the intensity and direction of emission of a certain light fixture. This is very useful if you want to use a certain light fixture from a manufacturer that also provides this information for it, but you don't want to actually model the fixture itself. The lighting pattern and intensity of the emitter will look correct, just as if you had actually modeled the fixture. You can use IES/EULUMDAT emitters with any type of geometry but for the most predictable results it is recommended you apply it on a small sphere. Please note that you cannot change the intensity of the emitter in this case since this information is provided from the .IES/.EULUMDAT file itself, but you can still change the color of the emitter.



F.01 IES

The Maxwell installation comes with a large collection of IES and Eulumdat files, and you can easily get more from lighting manufacturers or on the internet.

☑ *Important note: IES and Eulumdat files are commonly used to mimic lighting fixtures, using the lighting information files provided by manufacturers. They are handy because they can easily imitate the complex lighting effects produced by certain specific fixtures, without having to model the lamp itself. However, they must be used with care because they can sometimes produce physically incorrect results.*
Both formats contain the luminous intensity at any angle, measured in laboratory using light sensors located all over a spherical dome around the light source, pointing to the center of the dome so that the data capture method considers all lamps as point sources. This means that with these formats, the physical correctness of the result is highly dependent on the geometry you apply the IES/ Eulumdat files to.
To get the most physically correct results, IES/ Eulumdat files should be applied to small spheres to copy the laboratory environment they were measured in as much as possible. Applying an IES or Eulumdat file to a geometry other than a small sphere or using files captured from a non-point lamp can cause inaccuracies inherent to the method and format definition.

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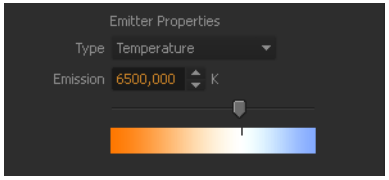
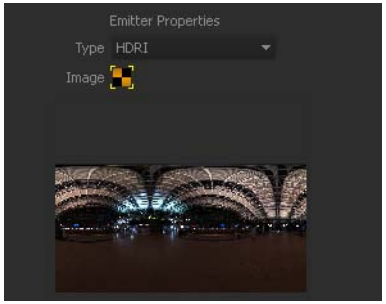
6.02 Temperature of Emission

The Temperature of Emission can be chosen in Kelvin degrees (ºK). Full Temperature of Emission mode affects not only the color but also the intensity of the emission. A higher temperature will make the emission stronger and bluer. The color will change from red (low temperature) to orange, to yellowish, to white, and finally blue (high temperature).



F.01 Temperature of emission

6.03 HDR Image



F.01 HDR image

This option allows you to texture an emitter with a MXI/ HDR/ EXR image. You can also use low dynamic range image (LDR), such as a jpeg, by first converting it from 8 bits to 32 bits using an image editing application, or Maxwell.exe. Simply open the image using File>Load Image and once the image is loaded go to File>Save MXI.

You can also use Maxwell.exe to adjust the intensity of the MXI/ HDR/ EXR map using the Intensity slider in the MXI section (found in the Edit panel).

Simply open your low-dynamic bitmap in the core rendering engine and save it to the MXI format. Maxwell Render will automatically convert your image to a high-dynamic range image. You can use the f-Stop and Intensity sliders to adjust your emitting image intensity.

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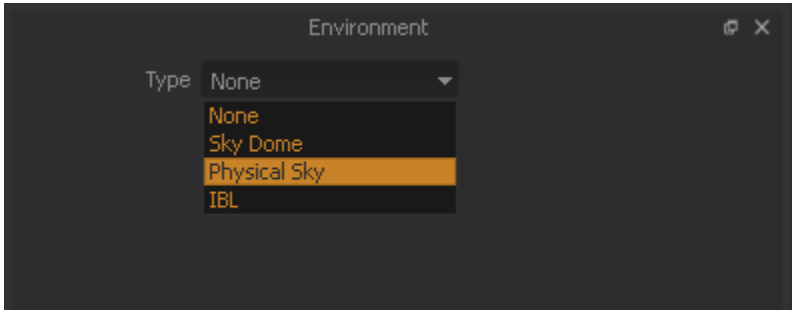
7 SETTING UP ENVIRONMENT LIGHTING

Note: In order to unify the look of this manual, the screenshots in this chapter were taken from the Studio interface, so they may have a slightly different look or position in other 3D platforms.

Besides the option to light your scene with emitters, there are four additional Environment lighting options: None, Sky Dome, Physical Sky and IBL (Image Based Lighting).



F.01 Environment types

7.01 None

No Environment lighting will be used. All the lighting in the scene will be provided by emitter materials.

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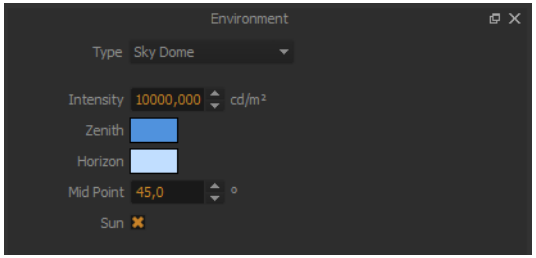
7.02 Sky Dome

Create a consistent color or gradient dome for lighting your scene.



F.01 Sky Dome options

- **Intensity (cd/m2):** Type in the intensity of the Sky Dome in cd/m2. It is a common way to specify how much light is emitted.
- **Zenith:** Specify the color of the dome at the zenith (the highest point above our head)
- **Horizon:** Specify the color of the dome at the horizon.
- **Mid Point (degrees):** Specify the transition between the Zenith and Horizon colors. This value indicates the angle at which the contribution of the colors is equal, where 0º and 90º correspond to Horizon and Zenith respectively. If you want a consistent color for your dome, simply choose the same color for both Zenith and Horizon slots. You can drag and drop colors from one color slot to the other, to copy the same exact color.
- **Sun:** When checked, Sky Dome will render together with the sun from the current Physical Sky settings. You can first adjust the sun by switching to the Physical Sky environment lighting and adjusting the location/ time/ date, and then switching back to Sky Dome.

7.03 Physical Sky

Maxwell Render™ has a sophisticated atmosphere model that reproduces the skylight conditions at different locations/ times/ dates. The atmosphere parameters allow users to customize the look of the sky and the resulting light in the scene. Users can also create pre-sets of the sky settings to quickly load a new sky or share their pre-sets with other users, or save a sky as an HDR/ EXR map.

- **Load:**
  - **From Disk:** Allows you to choose a location to load a .sky pre-sets file.
  - **From Google Earth File:** Allows you to choose a location by loading a Google Eath location file in .kml or .kmz formats.
  - **Preset:** The dropdown will list all the saved pre-sets found in the Maxwell/ skies folder.

- **Save:**
  - **As Preset:** Saves a .sky preset file in the Maxwell/ skies folder.
  - **As HDR:** First specify a location for the HDR file, then a resolution. The default format is a longitudinal HDR map (2:1 width to height ratio).

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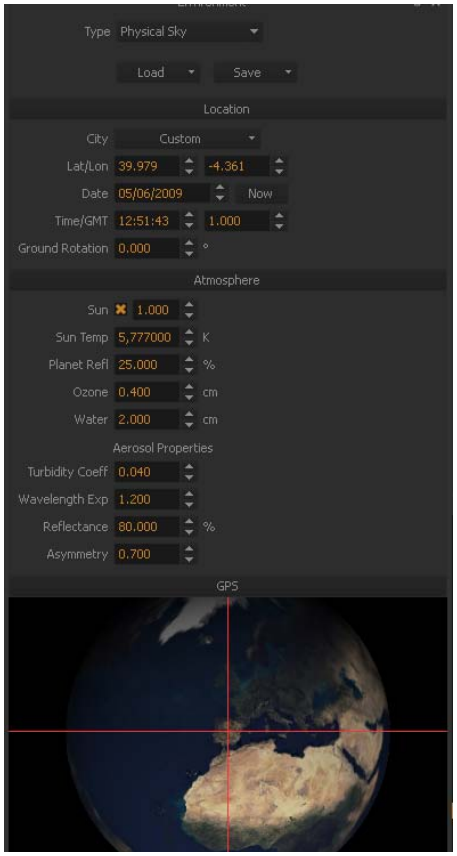
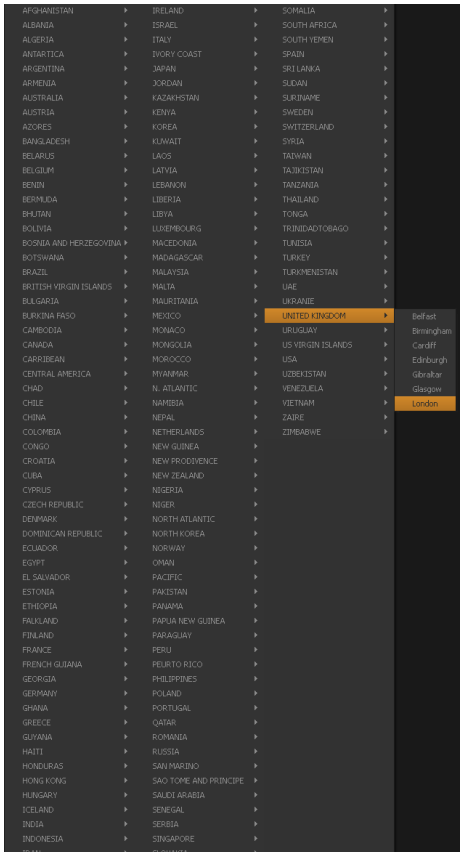
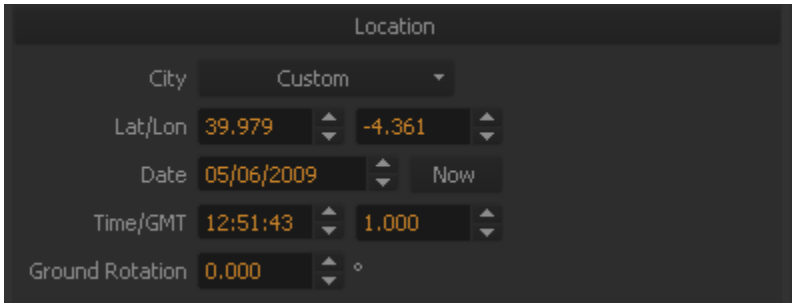


F.01 Physical sky options



F.02 Cities list

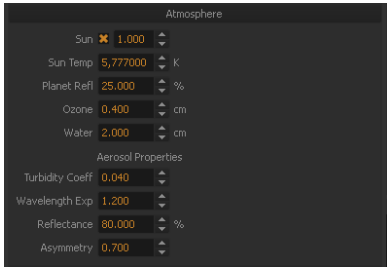
Location and Time:



F.01 Localition settings

- **City:** List of cities to quickly choose a location. The list is a text file which you can edit to add or delete locations. It can be found in your Maxwell installation folder (cities. txt).
- **Latitude/Longitude:** Earth positions to calculate the sky/ sun light direction.
- **Date/Now:** Set the date. Clicking the "Now" button sets the time and date to your computer's current time and date.
- **Time/GMT:** Set the time and the GMT offset.
- **Ground Rotation:** Allows you to rotate the north direction. This is useful when you want to reposition the sunlight without changing the location or date/ time settings which would change the sky illumination.
- **Google Earth™ Data:** Allows you to import a KMZ/ KML file to set the location.

Atmosphere:



F.01 Atmosphere settings

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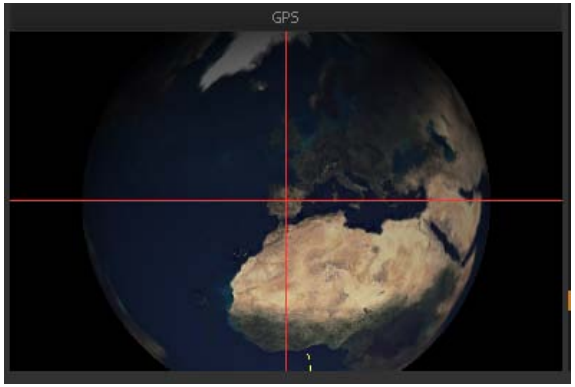
- **Sun:** Switch direct sunlight on/ off.
- **Sun Temperature:** Temperature of the sun's spectral radiation. The default value of 5777ºK is the most common value measured outside the Earth's atmosphere. Lowering this value will give the sky and scene illumination a yellow tint, higher values will give the illumination a blue tint. Although it is possible to change this value for different looks, it is better to leave it at default and instead change the other atmosphere parameters for accurate and predictable results.
- **Sun Power:** A multiplier that controls the amount of light emitted from the sun. Higher values than the default 1 will make the sun emit more light, lower values will emit less. A value of 2 means the sun in your scene emits twice as much light as the Earth's sun.
- **Planet Reflectance:** Controls the percentage of light reflected from the planet surface back into the atmosphere. Changing this value will brighten/ darken the overall sky and scene illumination with lower values giving a darker result. Common values are 26-32 %. This parameter is similar to the common term "Planet Albedo", which refers to light reflected from the planet surface plus the light reflected from cloud coverage. Albedo is the ratio of light reflected by an object to the total amount of light it receives. The albedo of an object can range from 0 (0% light reflected back) to 1 (100% light reflected back). The average albedo for the Earth is 0.3, which means on average the Earth reflects 30% of the light it receives back into the atmosphere. The albedo can vary greatly. Fresh snow has an albedo of about 0.8; forested areas have an albedo of 0.05-0.10, etc. Regional albedo values can be found online.



F.01 Globe (only available in studio)

Gas Properties:

- **Ozone:** The amount of ozone gas in the atmosphere. The default value of 0.4 centimeters means that if you gathered all the ozone in a vertical column stretching through the entire atmosphere, you would get a stack of ozone of 0.4cm high. Raising this value will result in the sky and scene illumination having a more blue tone, lowering it will produce a more yellow tone.
- **Water:** The amount of water vapor in the atmosphere. It is measured in centimeters, in the same way as ozone. This setting may not have much influence on the look of the sky at midday, but will have a clearer effect at sunrise and sunset. In those situations, raising the water value will make the sky look heavier and less saturated, with a red/ orange tone at the horizon, while the rest of the sky will turn a darker blue.

Aerosol Properties: The physical sky model in Maxwell Render adds parameters for aerosols: small particles found in the atmosphere. Light interacts with these particles as it travels through the atmosphere. They absorb and scatter light, which has a big impact on the coloration of the sky and scene illumination. The last four parameters control various aspects of the aerosols found in the atmosphere.

- **Turbidity Coefficient:** Defines the concentration and amount of particles in the atmosphere. A value of 0 creates a perfectly clear sky (in which case the next three parameters won't have any effect). 0.01 is a good value for low turbidity, e.g. a sky with very few aerosols in it so that it will appear almost clear. 0.04 is a good medium value and 0.1 is a high value. Raising the amount of particles in the atmosphere will usually result in a darker sky and darker scene illumination, but the effect depends also on the Scattering Asymmetry parameter (see below). In bright daylight situations and with a positive Scattering Asymmetry, raising the Turbidity Coefficient will at first desaturate and brighten the sky. Raising the parameter further will start to darken the sky. With negative asymmetry, the sky will begin to desaturate and darken. The following images show this effect:

  Raising the Turbidity Coefficient in sunset situations will darken the sky. Remember that you can also raise the ISO of the camera in these cases, which can reveal an interesting sky.

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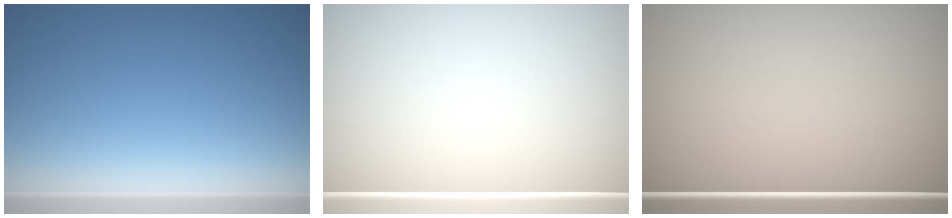
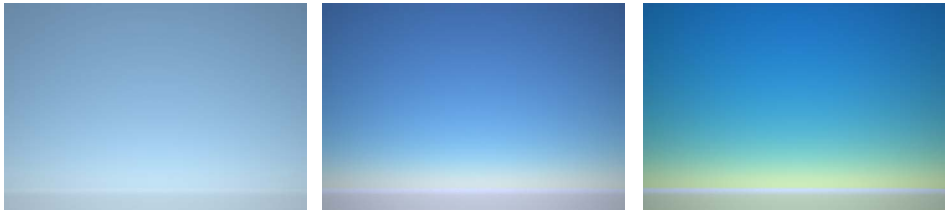


F.01 Default settings (0.04) F.02 Turbidity 0.65, Scatt. Asymmetry 0.7 F.03 Turbidity 0.65, Scatt. Asymmetry -0.7

Note: Very high Turbidity Coefficient values such as 0.5 are also possible for very dense aerosol atmospheres, for example after a volcano eruption.

- **Wavelength Exponent:** Defines the average size of the particles in the atmosphere. The particle size influences which wavelengths of light are absorbed and which are scattered. You can greatly vary the coloration of the sky by changing this parameter, and the effect of the Wavelength Exponent will be more visible the higher you set the Turbidity Coefficient. Having a lower value than the default 1.2 will have a desaturating effect on the sky. Higher values than the default will at first increase the saturation of the sky, until gradually turning towards green and then orange:



F.01 Default settings (Wavelenght Ex. 1.2) F.02 Wavelenght Ex. 10 F.03 Wavelenght Ex. 30

- **Reflectance:** Refers to the albedo of the aerosols, or the rate of energy scattered and absorbed by the aerosols. Higher values will scatter more light from the aerosols which will brighten the sky and scene illumination. Values range from 0 to 1. A value of 1 means that all light that interacts with the aerosols scatters, and none is attenuated.
- **Asymmetry:** This factor controls the anisotropy of the particles, that is, in which direction most of the light will be scattered. Light can be scattered along the same direction as the incoming sunlight (positive values), or back towards the direction of the sun (negative values). A value of 0 means that the light is scattered equally in all directions (isotropic value). Positive values will produce a halo effect around the sun, brightening the area around it. Negative Scattering Asymmetry values will have an overall darkening effect on the sky. Avoid setting a higher negative or positive Asymmetry setting than -0.85/ 0.85 as this will result in noisier renders.

Tips for working with the Physical Sky:

- Keep in mind that the atmosphere parameters influence each other. For example, if you raise the Turbidity Coefficient (more particles in the atmosphere), the Wavelength Exponent, Reflectance and Scattering Asymmetry parameters will then have a greater influence on the look of the sky: they are affecting a larger amount of particles.
- To keep the horizon from turning too bright, lower the Planet Reflectance and decrease the Scattering Asymmetry.
- Maxwell Studio and some of the plug-ins can interactively show an accurate OpenGL view of the current sky coloration and brightness. In Studio, press the "K" key to activate/ deactivate the Sky Preview. This OpenGL view also takes into account the cameras' f-Stop, ISO and Shutter Speed settings.
- The scene illumination and coloring change depending on what sky settings you use. If you raise the ozone level, which makes the sky scatter more blue light, your entire scene will have a bluer illumination.
- Because the Maxwell camera has a fixed white balance of 6500K, you can save your render in any of the HDR (High Dynamic Range) formats available, such as tiff32, .EXR, .HDR, and white balance your image in an image editing application that can handle HDR files.

7.04 Image Based Lighting (IBL)

Image Based Lighting allows you to light your scene by applying an HDR image to a virtual sphere that encompasses your scene. This is useful if you want your 3D model to appear as if it is actually in a real environment. The scene will be lit according to the properties of the HDR image and reflections from this environment will also show on your models. You can use an .HDR, .MXI or .EXR image for the IBL. These three image formats store high dynamic range data, providing accurate environment lighting. Please note that the images

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used for IBL should be in the Latitude/ Longitude format (the width should be twice the height). Images in "strobes" or "cross" formats will not work correctly.

> *Note: There are several available channels for specifying MXI/ HDR/ EXR maps. This is a powerful feature as it allows the user to have more control over the effects of the environment on the scene. For example, you can use one MXI/ HDR/ EXR map for the illumination of the scene, and another map for the reflections.*

- **Background channel:** Allows the addition of an MXI/ HDR/ EXR map as a background environment, supplying a background image in the scene. Screen mapping can be used to map the MXI/ HDR/ EXR image to screen coordinates. This channel does not provide any scene illumination or reflections.
- **Reflection channel:** Add an MXI/ HDR/ EXR map for reflections on scene objects.
- **Refraction channel:** Add an MXI/ HDR/ EXR map for refractions on scene objects.
- **Illumination channel:** Add an MXI/ HDR/ EXR map for scene illumination.

Each channel can be edited separately. The following options are available for each channel:

- **Disable:** The map will not be used for rendering.
- **Same as Background:** The same map and settings will be used as for the Background channel
- **Map:** Select the MXI/ HDR/ EXR map.
- **Intensity:** Adjust the intensity of the map to increase or decrease its contribution to scene illumination/ reflections/ refractions.
- **Scale:** Scale the current map.
- **Offset:** Rotate the spherical environment in the X and Y axis. 0 - 100 represents rotation from 0 to 360°.
- **Use for Disabled:** This option adds an extra control over the environment. If any of the MXI/ HDR channels are disabled, you have the option to use the Sky Dome, Physical Sky or None to replace the disabled channels. For example, if you disable the IBL Illumination channel and set "Use for Disabled" to Physical Sky, it will provide the illumination for the scene.
- **Interpolation:** This option can be useful when you have a low resolution HDR map and you see pixelisation in the HDR map when it is seen in the background, in reflective objects or through transparent objects. The pixels in the map will be interpolated to try and "blend" the pixels together to avoid the pixelated look.

F.01 IBL settings

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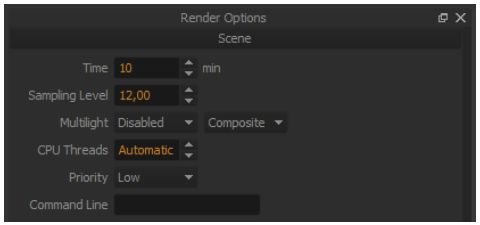
8 SETTING UP THE RENDER OUTPUT

Note: In order to unify the look of this manual, the screenshots in this chapter were taken from the Studio interface, so they may have a slightly different look or position in other 3D platforms.

8.01 General

The Maxwell Render approach to rendering is quite different from that of other rendering engines. Because of its physically correct behavior and spectral calculations of light, there is no concept of a "finished" render. The render will keep calculating until you stop it. There are two ways to stop a render in Maxwell Render: by setting a Sampling Level (SL: level of quality) or by setting a Render Time (in minutes). If you set both parameters, the render will stop when one of them is reached. This double approach gives you a lot of flexibility to control the quality.



F.01 Scene

Setting the Sampling Level is useful to ensure that all the frames of your sequence will reach the same quality level, regardless of the time needed for each specific frame. I.e. set SL to 10 and Render Time to 10.000 to ensure that the first condition to be reached is SL. Setting the Render Time is useful if you want to get results within a specific time frame. I.e. set you SL to 30 and the Render Time to 5 (minutes) to make sure that your render

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will stop in 5 minutes. If you are not sure what SL or Render Time to put to reach the desired quality, just put in high numbers for both so that the image keeps rendering. You can then check every once in a while to see if you are pleased with the quality of the image and stop the render anytime.

- **Time (min):** Set the maximum render time (in minutes) for the render. The longer the time, the cleaner and more accurate your image will be.
- **Sampling Level:** Maximum sampling level required. The render will stop when this SL is reached. As with the "render time" parameter, a higher sampling level will give a cleaner and more accurate image. It is important to know that there is no standard SL value to get an acceptable quality level, because it depends entirely on the scene. Some scenes can be completely noise-free at SL=8 or even earlier, while others may need to get to SL=16 or higher. It is important to remark that the Sampling Level standards were re-written for Maxwell Render version 2, so it cannot be used as a quality comparing parameter for images created in version 1.x and version 2.x. In fact, the same Sampling Levels in Maxwell 2 show a much higher quality than those in Maxwell 1.x.
- **Multilight:** Disabled / Intensity / Color enables the different Multilight modes. You can even choose between exporting all the emitters contribution to independent images (**Separate**), or saving only the composed render (**Composite**). For more information about Multilight, see The Core Rendering Application section in Chapter 9.04.
- **CPU Threads:** Number of threads dedicated to the render. By default, "Automatic" means that all available CPUs/ Cores will be used. In special situations you may require less threads if the machine is working on other tasks. Note that one core in a multi-core CPU is considered 1 CPU thread.
- **Priority:** You can set the rendering process to normal or low priority. This is useful if you wish to work on your computer while rendering. Setting the render to Low Priority does not mean the render will take longer to finish. If you are not using your computer for other things while rendering, Maxwell Render will still utilize the full capacity of your CPUs.
- **Command Line:** Pass command line parameters to Maxwell Render. More information about the available commands can be found in Appendix III. Any of the commands entered here will overwrite the render options. For example, you can render to a test resolution from command line without losing the final render parameters specified in the Resolution parameter in the Camera Parameters panel.

8.02 Output

F.01 Output

- **Depth:** Specify the bit depth for your chosen output format. Some formats such as .jpg only allow 8bits per color channel, others such as .exr and .tif allow up to 32bits per channel. Note that you must first write an output format in the Image field for this dropdown to become available. For example if you write myrender.png, the dropdown will let you choose from 8b or 16b because the png format allows these bit depths. Writing myrender.tif will let you choose from 8,16 and 32b.
- **Image:** Specify a name along with a suffix (.jpg, .bmp, .tif, .tga, .png, .jp2) and a path for the image file, created when rendering.
- **MXI:** Specify a name and path for the MXI file, created when rendering. An MXI file is always created when rendering. You can also drag n drop the folder icon from the Image field to copy/paste that path into the MXI field. The name you chose for your Image field will be appended the .mxi suffix (myrender.mxi).

  ☑ *Note: If you do not specify an output path, the image/ MXI will be saved according to the settings in Preferences> General in Studio or in the applicable section in your plug-in. The preference allows you to either save the image in the same folder as your .MXS file, or in your system's temp folder*

Output paths support macros in the image and MXI paths, so users can include important rendering information in the final image file name.

The supported macros are:

- **%scene% :** the name of the MXS file will be included in the final image file name.
- **%scenepath% :** the full path of the MXS file will be included in the final image file name.
- **%camera% :** the name of the active camera will be included in the final image file name.
- **%date% :** the date when the render was launched will be included in the final image file name, in mm.dd.yyyy format.

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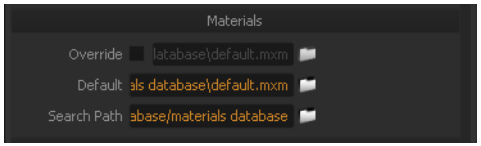
- **%time% :** the time when the render was launched will be included in the final image file name, in hh.mm format.
- **%temp% :** the full path of the temp folder of the OS will be included in the final image file name.
- **%version% :** the current engine version will be included in the final image file name.

Note that macros should be put in between % % signs. You can use quotation marks ("_") or any other character to separate them.

Example: \finalimage_%date%_%camera%.tga

8.03 Materials

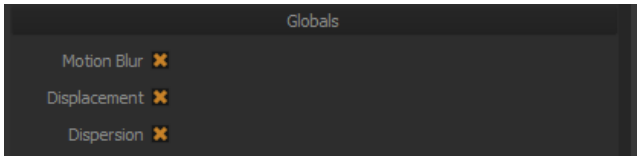


F.01 Materials

- **Override:** Check this option and specify a path to a .MXM file that will override all other materials in the scene (except materials with emitters). This is useful to quickly set up a "clay" render to check the illumination in your scene, or to mimic an ambient occlusion pass if needed.
- **Default:** Set the path for the default .MXM file used for objects that do not have a material assigned to them. Note that the default .MXM can also be set in the Preferences> Paths section in Studio.
- **Search Path:** Set the path where Studio should look for any textures and other files used in your scene to avoid "missing textures" errors when rendering. Note that in Studio you can also set several default search paths in Preferences> Materials> Textures.

8.04 Globals

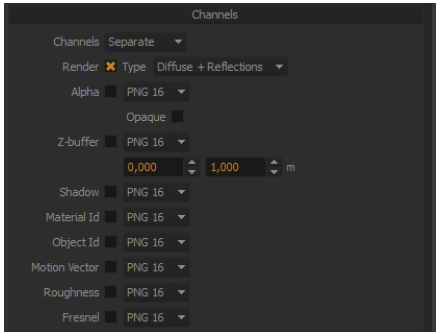
These checkboxes allow you to easily disable/enable the Motion Blur, Displacement and Dispersion calculations on your render, without the need of editing the scene or its materials.



F.01 Globals

8.05 Channels

Several render channels are available, useful for compositing tasks. You can enable the channels you need and choose the file format for each channel. The output will be saved in the same directory as set in the Output options.



F.01 Channels

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- **Channels:** Allow you to determine whether you want your channels to be exported as independent files (**Separate**), or embedded as one single file (**Embedded**) in the formats that allow extra buffers, like exr or tif. The Alpha channel can be embedded in the tga, png, tiff and exr formats.

- **Render:** Output the main render image. You can choose between three main render types:

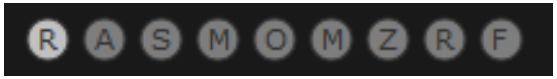
    - Diffuse+Reflections: Which is the usual complete render. Output the whole render including diffuse and reflections.
    - Diffuse: Output an image containing only the diffuse color of the surfaces.
    - Reflection: Output an image containing only the reflective component of the surfaces.

- **Alpha:** Output the alpha channel. The alpha channel is a black & white image containing information about where a specific object exists and where it does not. It is useful as a clipping mask when you want to isolate an object and composite it with another object (for example: clipping a car render and pasting it over a photograph). It is also possible to render a completely white alpha for transparent objects with the Opaque option. If this option is unchecked, transparent materials will render with a transparent alpha.
- **Z-buffer:** Output an image representing scene depth within the two values specified in the Z-buffer range. The range is in meters. For common usage, you should specify the range from the camera to the farthest object in your scene. This is useful to create a depth of field effect as a post process in an image editor that can use a Z-buffer image to extract depth info.
- **Shadow:** Output a shadow channel. This channel is a grayscale image that represents the shadows received by objects that have a material applied to them with the "Shadow" option turned on. This is useful to composite the shadows cast by a rendered object into a photograph. The "Shadow" option must be enabled for the desired shadow-catching material. This can be done in the Material Editor of the specific material (see chapter 10 about Materials).

    ☑ *If the Multilight feature is enabled, Maxwell exports all the shadow buffers corresponding to each individual light emitter separately during the same render process, as well as a shadow pass of all the shadows cast by each emitter "blended" together, giving an extraordinary control over the compositing during the post-production process. For example you can change the brightness of an emitter using MultiLight which could then brighten up the shadow cast by another emitter. The blended shadow pass image will take these changes into account..*

- **Material ID:** Output multicolored material silhouettes. This is useful for easier selections in a 2D image editor when you want to edit only specific materials in the rendered image.
- **Object ID:** Output multicolored object silhouettes. This is useful for easier selections in a 2D image editor when you want to edit only specific objects in the rendered image.
- **Motion Vector:** Output the x,y,z translation of each pixel. Useful to apply motion blur in compositing as a post process.
- **Roughness:** Output an image containing the Roughness value of the materials in the scene. High Roughness materials will appear white in the image, while low Roughness materials will appear dark.
- **Fresnel:** Output an image containing the Fresnel information of the surfaces.

During the render, you can display the specific render channels that you've requested by hovering over the channel buttons in the render view.



The icons represent:
R: Render channel
A: Alpha channel
S: Shadow channel
M: Material Id channel
O: Object Id channel
M: Motion vector channel
Z: Depth channel
R: Roughness channel
F: Fresnel channel

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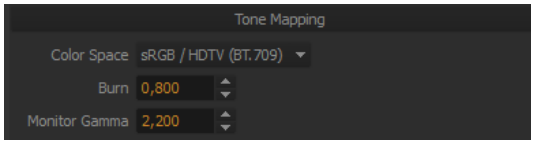
8.06 Tone Mapping

- **Burn:** Parameter to control the highlights in a render. Lower burn values will decrease the intensity of the highlights to avoid "burned out" areas in the image. In most cases this parameter should be left at default. Lowering it too much may produce unnatural looking images.



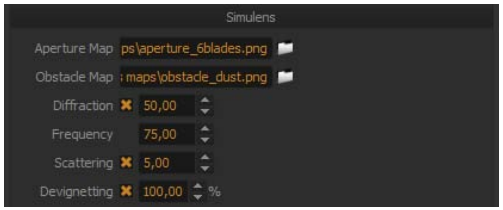
F.01 Tone Mapping

- **Monitor Gamma:** Maxwell Render™ internally uses a gamma of 2.2 to convert from spectral space to RGB space. You can use this parameter to control the gamma conversion. Lower gamma values darken the image, higher values lighten the image. Note that you can control this parameter interactively while rendering in core rendering application.

- **Color Space:** Choose your desired color space for the rendered image. Available color spaces are sRGB, Adobe 98, Apple RGB, PAL, NTSC, Wide Gamut, ProPhoto RGB, ECI RGB, CIE 1931 , Bruce RGB.

8.07 SimuLens

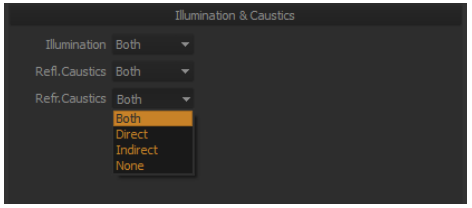
This section allows you to set the Maxwell SimuLens parameters. Detailed information about these parameters can be found in the core rendering application section in Chapter 9.03.04.



F.01 SimuLens

8.08 Illumination and Caustics

These controls allow you to deactivate certain aspects of the rendering calculations, such as Indirect Light or Reflected Caustics. This is useful in special cases where you want to see the effect of just the indirect light in the scene, or for compositing purposes.



F.01 Illumination and Caustics

- **Illumination:** Render only direct light, only indirect light, or both. Direct light is light that illuminates an object directly without first having bounced off another object.

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- **Refl. Caustics:** Render direct reflective caustics, indirect reflective caustics, or both. Direct reflective caustics come from light that bounced off a specular reflective object and created caustic light patterns on any subsequent object. Indirect reflective caustics come from light that bounced off an object, then off a specular reflective object, and then created a caustic light pattern on any subsequent surface.
- **Refr. Caustics:** Render direct refractive caustics, indirect refractive caustics, or both. Direct refractive caustics come from direct light that has passed through a transparent material and has created a caustic light pattern on any subsequent surface. Indirect refractive caustics come from light that has first bounced off a surface, then passed through a refractive object, and caused a caustic light pattern on any subsequent surface.

8.09 Render Export Options

Due to the different characteristics of the available output formats, the required extra channels for exporting, and the Multilight options, you have a wide range of export options depending of the needs of your project.

We can show all the possibilities in this tree:

8.09.01 Multilight Disabled

Regarding the light emitters: you will get one single file with the contribution of all emitters merged in one single image (RGB or RGBA if your output format supports embedding alpha and you enable the alpha channel exportation).

Regarding the extra channels for exporting: you may want them to be

- Embedded into the main output file if its format supports this:
  - EXR, TIFF and MXI will embed all the enabled extra channels into the main render file.
  - TGA and PNG can embed only the alpha channel into the main render file (RGBA). The rest of the extra channels will be stored in independent files.
  - JPG, BMP, JPG2000 and HDR do not support embedding alpha or any extra channels. All the extra channels will be exported to independent files.
- Separate: getting independent files for all the required extra channels in all cases (all formats)

8.09.02 Multilight Enabled

Regarding the light emitters: you may want to store each emitter contribution to independent files or have them all as layers in one multi-layered file:

- Composite: all your light emitters will be stored as different layers in one multi-layered file, in those formats that allow multiple layers (EXR, TIFF and MXI). For the rest of the formats (TGA, PNG, JPG, BMP, JPG2000 and HDR) the emitters will be stored as independent files, as those formats do not support multiple image layers.

- Separate: you will get a collection of individual files corresponding to the different emitters in the scene.

Regarding to the extra channels exportation: you may want them to be

- Embedded into the main output file if its format supports this:
  - EXR, TIFF and MXI will embed all the enabled extra channels into the main render file.
  - TGA and PNG can embed only the alpha channel into the main render file (RGBA). The rest extra channels will be stored to independent files.
  - JPG, BMP, JPG2000 and HDR do not support embedding alpha or any extra channels. All the extra channels will be exported to independent files.

- Separate: getting independent files for all the required extra channels in all cases (all formats)

Keep in mind that in order to get the alpha channel embedded in the main render file (in those formats that support embedded alpha), you have to set the exportation of the alpha channel at the same bit depth as the main render file. Otherwise it will be exported to an independent file with the indicated bit depth and format.
The MXI files (containing all the emitters and all the extra channels) can be opened in Maxwell Render, or in Adobe Photoshop, Adobe After Effects and Nuke through the Import MXI connection plug-ins (See chapter 3.01.02).

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Note: If you need to adjust the color of your emitters in your postproduction platform (rather than in Maxwell Render), then you don't need to launch your render with the Color Multilight mode (which is only involved in the color adjustments inside Maxwell Render). You may prefer to use the Intensity Multilight mode, as it will preserve all your color adjusting capabilities in postproduction, while generating a much smaller MXI file.

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9 THE CORE RENDERING APPLICATION

The core rendering application in Maxwell Render (previously called MXCL) is the engine which computes your render and shows you the final image. The component is called Maxwell.exe in Windows, Maxwell.app in Mac OSX and Maxwell in Linux. It provides a standalone interface that allows users to load MXS scenes to render, view the rendering progress and adjust render parameters. Many of these parameters can be adjusted while the render is in progress. When adjusting parameters, the small preview image will show you the results in real-time.
The core rendering engine interface is opened automatically when a scene is launched to render.

The MXI format:
The core rendering application also allows users to load MXI files, the Maxwell Render™ native file format. An MXI file is always created when rendering with Maxwell Render™. It contains high dynamic range image data and other Maxwell Render™ data stored during the render process.
Information about calculations and the light conditions in your scene is also stored in the MXI file. This information is extremely important. As long as you have your render in MXI format, you will always be able to tune your image or resume your render after stopping it. The MXI file also contains all the info from the camera used to generate that render.

9.01 The core rendering application interface

The core rendering engine offers a complete user interface which is easy to use, flexible and visually attractive. All the panels are dockable so it is easy to customize the interface. The panels can be re-sized by simply dragging their borders. Fields and sliders will re-shape to fill spaces, providing more comfort.
You can display the panels as floating panels using the Detach icon, or you can arrange them in the interface by dragging them to the desired location. The interface will automatically re-arrange to create space for the new panel. You can also create tabs which hold different panels by dropping the panel on top of another panel.

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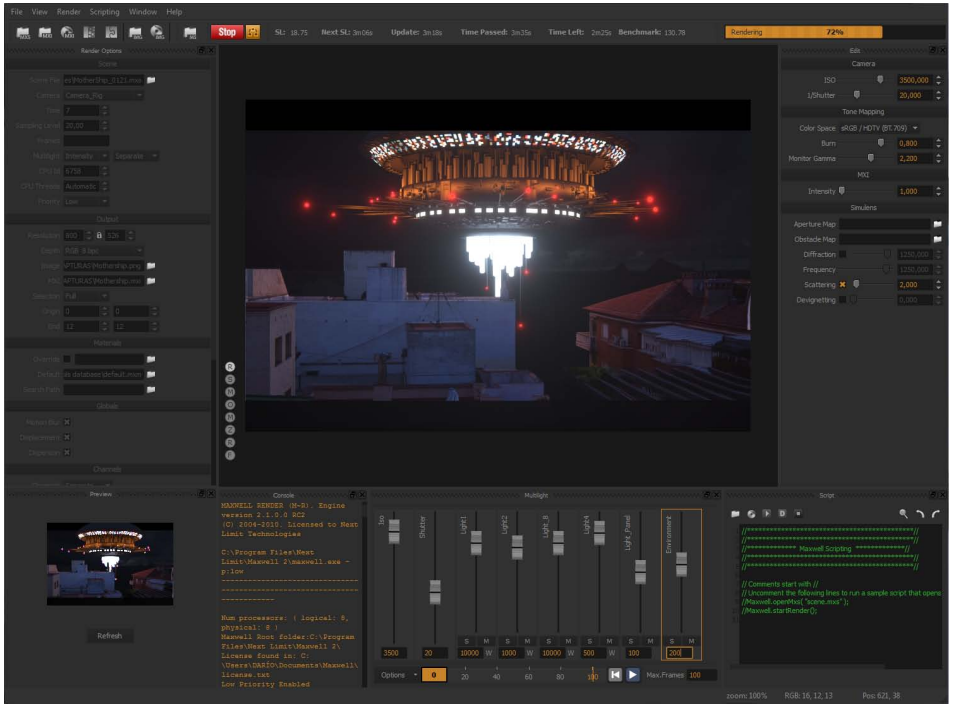

F.01 Maxwell Render UI

9.01.01 Top Menus

At the top of the Maxwell UI, you will see the different menus available in The core rendering engine.

F.01 Menus panel

File:

- **Open MXS:** Open a MXS file generated from the plug-ins or from Studio. You can then set the render and output options from the Render Options panel and click the Render button to start rendering.
- **Open MXI:** Open a MXI file which you can then adjust using Multilight and the render settings in the Edit panel.
- **Save MXI as:** This menu option can be used to convert a bitmap to the MXI format for use as an Image emitter in your scenes. For more details, see the Load Image menu option.
- **Merge MXI:** Select several MXI files that were rendered on different computers and merge them together to obtain a higher Sampling Level. This is normally done automatically when using network rendering, but this option can be useful in case you are using computers for rendering which are not connected in network.
- **Merge MXI Sequence:** In certain situations you may have several MXI files (i.e. several frames in an animation sequence) rendered by multiple computers, each with the complete sequence of MXI frames. In this case you may want to merge each frame with the same frame in the other computers to obtain the final sequence. This option allows you to specify all the folders to merge (with its "Add Folder" tool), and each frame will be merged with the same frame in the other folders, obtaining a single, complete sequence.
- **MXI Batch Processing:** This tool allows you to edit a group of MXI files, applying the same modifications to all of them. You can change the ISO, Shutter, Tone Mapping, SimuLens, and Multilight settings. You can also extract the render images and the channels from the MXI files, export the emitters as separated images, and make changes in the emitters' intensity (overwriting original files, or not). Simply select the input folder where the MXI files are located, and specify an output folder. You can use the "File Name Filter" to filter the file selection, and use the "View affected files" option to review the MXI files that will be processed.

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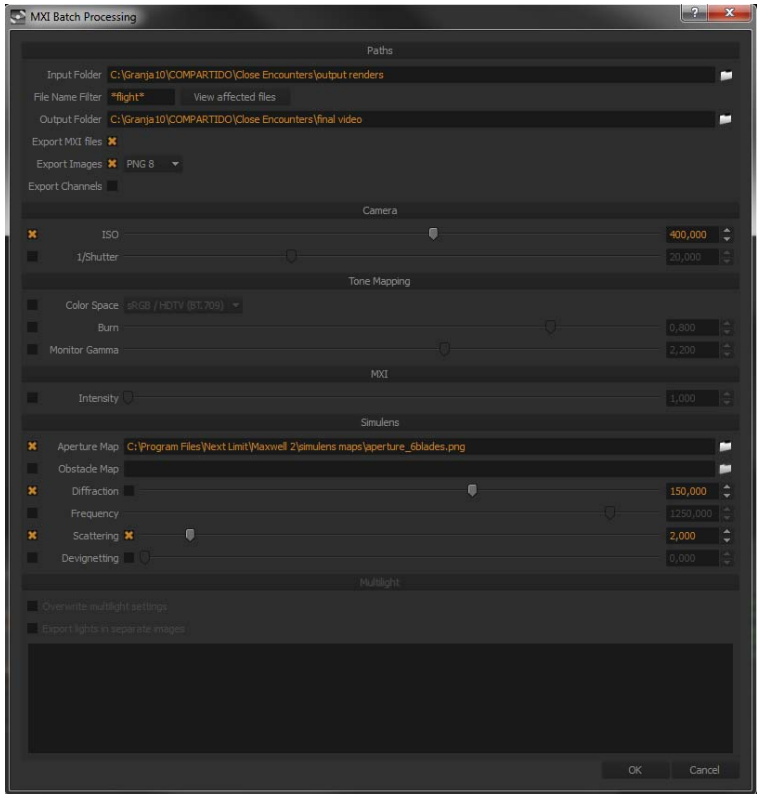

F.01 MXI Batch Processing

- **Resume MXI:** Select a MXI file to resume rendering. After specifying a MXI file, the corresponding MXS file will be loaded in Maxwell Render and rendering will resume automatically from where it left off. Please note that the resume render will not work if you have made any changes in the MXS or if the location of the MXS has changed.
- **Load Image:** Convert a bitmap into a MXI which can then be used as an Image emitter in your scenes. After loading the image you can use the Intensity settings from the Edit panel (MXI section) to change the brightness of the MXI emitter. Brighter settings will make the MXI emit more light. Use the "Save MXI as" menu option to save the image in the MXI format. Please note that if your bitmaps are in HDR or EXR format they do not need to be converted to the MXI format; you can use these formats directly as Image Emitters.
- **Save Image:** Save a bitmap of your render. After clicking Save in the dialog, a second menu will appear, allowing you to choose the bitdepth. Depending on the format you have chosen in the Save Dialog, you can save in 8, 16 or 32 bit output.
- **Preferences:** Open the preferences dialog to set preferences for notification messages, texture repository paths where Maxwell Render will look if any textures are missing, exporting channels formats, and general issues. The General Preferences tab allows you to change the look of the interface, specify where output files will be stored, or indicate a minimum time for saving to disk (in minutes). Using this option, you can improve the performance in systems where the writing process is very slow. For example, if the output folder is to a USB stick, it may be better not saving to disk frequently during the first sampling levels, but rather when a certain amount of time has passed. By default, the value is set to "Automatic", which means that Maxwell Render saves to disk as usual (i.e. when a new SL is reached).
- **Recent MXS/ Recent MXI:** Display a list of the recently opened MXS/ MXI files.
- **Quit:** Close Maxwell Render.

View: Visualize your scene in different ways, using tools like Zoom, Pan, Rotate, Full Size, display the Render, or display different Channels.
Render: Start, stop, or resume the render process. You can also launch the current scene in network, using the option "Render via Network". This option launches a Monitor (or uses the existing Monitor if there is one running on the same machine), and opens the Job Wizard automatically, lining up a new job with the current scene. Of course there must be one Manager and at least one Rendernode running to be able to render in network.
Scripting: Load and run a script file to automate the rendering process. See the Scripting chapter for more information about Scripting. The Scripts menu option shows a list of the scripts available in the "scripts" folder in the Maxwell installation folder. For quick access to scripts you should save any scripts you use regularly in this folder.

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Script
// This script gets all the mxs's located in the folder "input" and its children
// Opens them, change their SL and resolution and launch each render
// The images are stored in the folder "output"
var inputFolder = "C:\\input";
var outputFolder = "C:\\output";
var engineVersion = Maxwell.getEngineVersion();
var mxsCount = Maxwell.getNumberOfFilesInBranch(inputFolder, "*.mxs");
var mxsList = Maxwell.getFilesInBranch(inputFolder, "*.mxs");
for(var i = 0; i < mxsCount; i++)
{
var mxsFile = mxsList[i];
Maxwell.print("rendering Mxs file: " + mxsFile);
Maxwell.openMxs(mxsFile);
Scene.setSamplingLevel(3);

F.01 Scripting

Window: Open or close the different panels available (Render Options, Edit, Preview, Console, Script, Multilight).
Help: Get information about the software version, open the Maxwell manual, or access the THINK! learning website where you can find free tutorials and video tutorials to help you to improve your Maxwell Render skills.

9.01.02 Main Toolbar

The Main Toolbar provides several important tools in Maxwell Render and shows information about the rendering process. Right-click in the Render Toolbar to choose the panels and buttons you would like to display, and specify if you want to lock any of them. It is also possible to arrange the different tools and icons in this bar by dragging its handlers.

F.01 Status Bar

- **Open MXS, Open MXI, Save MXI, Resume MXI, Merge MXI, Load Image** and **Save Image** icons.
- **Render:** Start the render process. This button changes to a Stop button when the render is started.
- **Render via Network:** This option launches a Monitor (or uses the existing Monitor if there is one running on the same machine), and opens the Job Wizard automatically, lining up a new job with the current scene. Of course, there must be one Manager and at least one Rendernode running to be able to render in network.
- **Render Progress Bar:** Graphically visualize the progress of your render.
- **SL:** Shows the current sampling level.
- **Next SL:** Time to next sampling level.
- **Update:** Time to next image update between samples.
- **Time passed:** Total time elapsed.
- **Time Left:** Time left to finish. Because Maxwell will stop rendering when either the final Sampling Level (SL) or render time specified by the user is reached, the Time Left will either show an estimation of how long it will take to reach the final SL (when the user set a very high render time but low SL) or will show how much is left from the render time set by the user (when the user set a low render time and high SL). Maxwell Render calculates how long it took to reach the first SL to decide which parameter will be reached first: the SL or the render time.
- **Benchmark:** The Maxwell Render benchmark number. A higher benchmark number signifies faster rendering. The benchmark number is a scene-dependent parameter.
- **Run Script:** Load and run a script file.

9.01.03 Main Window

The main window shows your render in full resolution. When the render has just been launched, the core rendering engine updates the main image at every new SL reached. If the next SL level takes more than 10 minutes to complete, new updates will come every 10 minutes instead of when the next SL is reached, showing the incremental SL. Use the "H" shortcut key to hide the rest of the panels to maximize the render view, or the **"F"** shortcut (full screen) to hide the rest of the panels including the Render Toolbar. You can also right-click in the main window to get a menu with the same options found in the View menu.

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9.02 The Render Options Tab: setting up the render

F.01 Render Options

The following options are specific to the core rendering engine:

9.02.01 Scene

The Maxwell Render approach to rendering is quite different from that of other rendering engines. Because of its physically correct behavior and spectral calculations of light, there is no concept of a "finished" render. The render will keep calculating until you stop it. There are two ways to stop a render in Maxwell Render: by setting a Sampling Level (SL: level of quality) or by setting a Render Time (in minutes). If you set both parameters, the render will stop when one of them is reached. This double approach gives you a lot of flexibility to control the quality.

Setting the Sampling Level is useful to ensure that all the frames of your sequence will reach the same quality level, regardless of the time needed for each specific frame. I.e. set SL to 10 and Render Time to 10.000 to ensure that the first condition to be reached is SL. Setting the Render Time is useful if you want to get results within a specific time frame. I.e. set you SL to 30 and the Render Time to 5 (minutes) to make sure that your render will stop in 5 minutes. If you are not sure what SL or Render Time to put to reach the desired quality, just put in high numbers for both so that the image keeps rendering. You can then check every once in a while to see if you are pleased with the quality of the image and stop the render anytime.

- **Scene File:** Specify the location of the MXS file.
- **Camera:** Choose which camera in the MXS should be used for rendering.
- **Time (min):** Set the maximum render time (in minutes) for the render. The longer the time, the cleaner and more accurate your image will be.
- **Sampling Level:** Maximum sampling level required. The render will stop when this SL is reached. As with the "render time" parameter, a higher sampling level will give a cleaner and more accurate image. It is important to know that there is no standard SL value to get an acceptable quality level, because it depends entirely on the scene. Some scenes can be completely noise-free at SL=8 or even earlier, while others may need to get to SL=16 or higher. It is important to remark that the Sampling Level standards were re-written for Maxwell Render version 2, so it cannot be used as a quality comparing parameter for images created in version 1.x and version 2.x. In fact, the same Sampling Levels in Maxwell 2 show a much higher quality than those in Maxwell 1.x.
- **Frames:** Specify a range of MXS frames to be rendered. For example: 5,8,9 will render frames name0005.mxs, name0008.mxs and name0009.mxs. To render frames 1 through 10, type in 1-10.

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- **Multilight:** Disabled / Intensity / Color enables the different Multilight modes. The options Embedded/Separated allow you to export all emitter results to independent images, or save only the composed image. For more information about Multilight, see chapter 9.04.
- **Cpu Id:** This parameter is set back to a random value each time a MXS is opened. It can be used to render the same MXS file on different computers that are not connected in the same network. The resulting MXI files of each render can then be copied manually to the same computer and merged in Maxwell Render using File> Merge MXI. The MXI files need a random seed value for the merging to work properly. Normally you won't have to worry about this parameter. Just let Maxwell Render work by itself.
- **CPU Threads:** Number of threads dedicated to the render. By default, "Automatic" means that all available CPUs/ Cores will be used. In special situations you may require less threads if the machine is working on other tasks. Note that one core in a multi-core CPU is considered 1 CPU thread.
- **Priority:** You can set the rendering process to normal or low priority. This is useful if you wish to work on your computer while rendering. Setting the render to Low Priority does not mean the render will take longer to finish. If you are not using your computer for other things while rendering, Maxwell Render will still utilize the full capacity of your CPUs.

☑ *Tip: The browse folder icons in this section can be dragged and dropped, allowing you to copy file locations simply dragging a folder icon over another.*

☑ *Note: If the Multilight feature is enabled, Maxwell exports all the shadow buffers corresponding to each individual light emitter separately during the same render process, as well as a shadow pass of all the shadows cast by each emitter "blended" together, giving an extraordinary control over the compositing during the post-production process. For example you can change the brightness of an emitter using MultiLight which could then brighten up the shadow cast by another emitter. The blended shadow pass image will take these changes into account.*

9.02.02 Output

- **Resolution:** Specify the size (in pixels) of the image to be rendered. When the lock icon is enabled, the horizontal and vertical resolution values maintain the same aspect ratio.
- **Depth:** Specify the bit depth for your chosen output format. Some formats such as .jpg only allow 8bits per color channel, others such as .exr and .tif allow up to 32bits per channel.
- **Image:** Specify a name along with a suffix (.jpg, .bmp, .tif, .tga, .png, .jp2) and a path for the image file, created when rendering.
- **MXI:** Specify a name and path for the MXI file, created when rendering. An MXI file is always created when rendering.

☑ *Note: If you do not specify an output path, the image/ MXI will be saved according to the settings in Preferences> General in Studio or in the applicable section in your plug-in. The preference allows you to either save the image in the same folder as your .MXS file, or in your system's temp folder*

- **Selection:** Specify if you want to render the full frame at the desired resolution, render a particular region (defined by the Origin and End numeric fields), or blow up a region (defined by the Origin and End numeric fields) at the desired resolution. You can also draw the desired region using the marquee icon.

9.02.03 Materials

- **Override:** Check this option and specify a path to a .MXM file that will override all other materials in the scene (except materials with emitters). This is useful to quickly set up a "clay" render to check the illumination in your scene, or to mimic an ambient occlusion pass if needed.
- **Default:** Set the path for the default .MXM file used for objects that do not have a material assigned to them. Note that the default .MXM can also be set in the Preferences> Paths section in Studio.
- **Search Path:** Set the path where Studio should look for any textures and other files used in your scene to avoid "missing textures" errors when rendering. Note that in Studio you can also set several default search paths in Preferences> Materials> Textures.

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9.02.04 Globals

This checkboxes allow you to easily disable/enable the Motion Blur, Displacement and Dispersion calculations on your render, without the need of editing the scene or its materials.

9.02.05 Channels

Several render channels are available, useful for compositing tasks. The output will be saved in the same directory as set in the Output options.

- **Channels:** Allow you to determine if you want your channels to be exported as independent files (**Separate**), or embedded in one single file (**Embedded**) in the formats that allow extra buffers, like exr or tif. The Alpha channel can be embedded in the tga, png, tiff and exr formats.

- **Render:** Output the main render image. You can choose between three main render types.

    - Diffuse+Reflections: Which is the usual complete render. Output the whole render including diffuse and reflections.
    - Diffuse: Output and imagen containing only the diffuse color of the surfaces.
    - Reflection: Output an image containing only the reflective component of the surfaces.

- **Alpha:** Output the alpha channel. The alpha channel is a black & white image containing information about where a specific object exists and where it does not. It is useful as a clipping mask when you want to isolate an object and composite it with another object (for example: clipping a car render and pasting it over a photograph). It is also possible to render a completely white alpha for transparent objects with the Opaque option. If this option is unchecked, transparent materials will render with a transparent alpha.
- **Z-buffer:** Output an image representing scene depth within the two values specified in the Z-buffer range. The range is in meters. For common usage, you should specify the range from the camera to the farthest object in your scene. This is useful to create a depth of field effect as a post process in an image editor that can use a Z-buffer image to extract depth info.
- **Shadow:** Output a shadow channel. This channel is a grayscale image that represents the shadows received by objects that have a material applied to them with the "Matte Shadow" option turned on. This is useful to composite the shadows cast by a rendered object into a photograph. The "Matte Shadow" option must be enabled for the desired shadow-catching material. This can be done in the Material Editor of the specific material (see chapter about Materials).

    ☑ *Note: Multishadow: If the Multilight feature is enabled, Maxwell exports all the shadow buffers corresponding to each individual light emitter separately during the same render process, giving you an extraordinary control over the composition during the post-production process.*

- **Material ID:** Output multicolored material silhouettes. This is useful for easier selections in a 2D image editor when you want to edit only specific materials in the rendered image.
- **Object ID:** Output multicolored object silhouettes. This is useful for easier selections in a 2D image editor when you want to edit only specific objects in the rendered image.
- **Motion Vector:** Output the x,y,z translation of each pixel. Useful to apply motion blur in compositing as a post process.
- **Roughness:** Output an image containing the Roughness value of the materials in the scene. High Roughness materials will appear white in the image, while low Roughness materials will appear dark.
- **Fresnel:** Output an image containing the Fresnel information of the surfaces.

During the render, you can display the specific render channels that you've requested by hovering over the channel buttons in the render view.

To switch the channel displayed, it is enough to hover over the channel button instead of clicking it.

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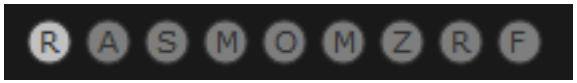
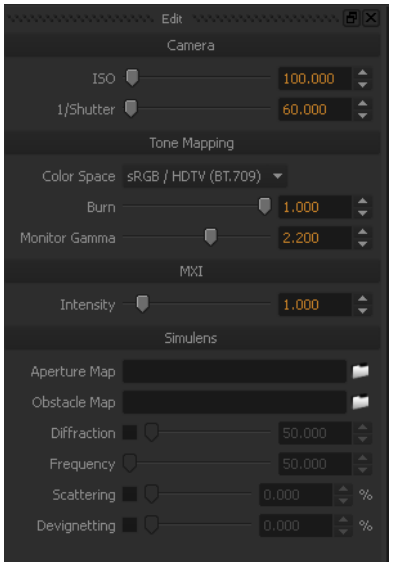


The icons represent:
R: Render channel
A: Alpha channel
S: Shadow channel
M: Material Id channel
O: Object Id channel
M: Motion vector channel
Z: Depth channel
R: Roughness channel
F: Fresnel channel

Note: The Color MultiLight feature and the Shadow Channel exportation are incompatible, so if both features are enabled together the render will be stopped and an error message will appear in the Maxwell console.



F.01 Edit Tab

9.03 The Edit Tab: editing the render

The Edit panel allows you – among other things – to adjust the exposure of your image during rendering and after the render has finished. The changes are displayed interactively in the Preview Image and will be reflected in the main render with each render update.

The following parameters are similar to those explained in Chapter 8.

9.03.01 Camera

- **ISO:** Sensitivity of the film to light. The higher the ISO number, the more sensitive the film will be to light, resulting in a brighter image. Please note that this parameter does not add grain/ noise to your image as is the case in the real world with higher ISO films.
- **1/Shutter (s):** The shutter speed, specified in 1/n of a second. Specifies the time light has to reach the film. The higher the specified number, the less time the light has to reach the film, resulting in a darker image.

9.03.02 Tone Mapping:

Tone Mapping changes the dynamic range of an image.

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- **Color Space:** Choose your desired color space for the rendered image. Available color spaces are sRGB, Adobe 98, Apple, APL and NTSC.
- **Burn:** Parameter to control the highlights in a render. Lower burn values will decrease the intensity of the highlights to avoid "burned out" areas in the image. In most cases this parameter should be left at default. Lowering it too much may produce unnatural-looking images.
- **Monitor Gamma:** Maxwell Render™ internally uses a gamma of 2.2 to convert from spectral space to RGB space. You can use this parameter to control the gamma conversion. Lower gamma values darken the image, higher values lighten the image. Note that you can control this parameter interactively while rendering incore rendering application.

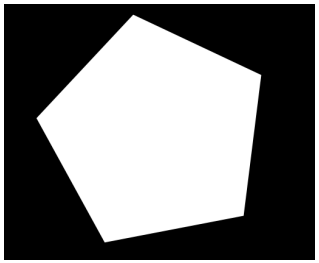
9.03.03 MXI

These parameters should be used when converting a low dynamic range image into a MXI to use it as an Image Emitter in your scenes. It is recommended to use the ISO/ Shutterspeed settings instead to control the exposure of the image when rendering.

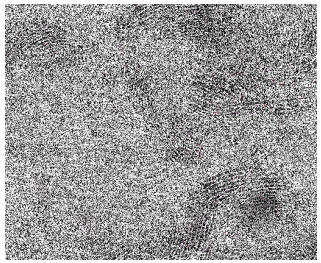
- **Intensity:** Intensity of the emission map. Raise this parameter to brighten the image, which will then emit more light when used as an Image Emitter.

9.03.04 SimuLens™

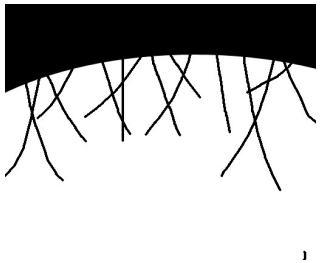
The SimuLens™ system mimics certain optical effects found in all camera lenses. They can add more realism to your renders.



F.01 Aperture 5 blades



F.02 Obstacle dust



F.03 Obstacle Fingerprint

Diffraction effects occur when light goes through small holes, causing interference patterns in the shape of the lens aperture. Light will always cause slight interference patterns because of the optical components used, causing the visual "artifact" known as glare. The diffraction effect can also be applied to HDR images. Simply load a HDRI using the File> Load Image option and apply diffraction to it.

- **Aperture Map:** The shape of the diaphragm will model the pattern of light that reaches the film. For example, a circular diaphragm will create circular patterns; a hexagonal diaphragm will create 6 light streaks. You can set the diaphragm shape using a black & white or color map called the aperture map.
- **Obstacle Map:** Water drops, eyelashes or dirt on the camera lens will also cause diffraction effects. A black & white map called the obstacle map is needed. If you do not want to use an obstacle map, you can leave this path blank: you only need an aperture map for diffraction to work. However, if you do want to use an obstacle map, be aware that it is necessary to load an aperture map too.
- **Diffraction:** Control diffraction/ glare intensity.
- **Frequency:** Control the frequency of coloring in the diffraction effect. Higher values will make the patterns denser.

The obstacle map and the aperture map must have the same resolution. Your render and the maps used do not always need to have the same resolution, but the more similar they are in resolution, the less diffraction distortion you will get. The aperture map should be black with white specifying the shape and size of the aperture. The obstacle map should be white with black areas specifying dirt or scratches on the lens surface.

- **Scattering:** Commonly known as bloom, scattering occurs when the light is scattered inside the lens before reaching the film.

☑ *Please note that the Diffraction and Scattering effects will be more visible the stronger the light source is. For example, if the camera sees the sun or a strong emitter, these will have a stronger diffraction/ scattering effect. The diffraction/ scattering effects will still be visible in the scene even if no direct light sources are seen by the camera, but the effect will be weaker.*

☑ *Tip: Do not enable any Simulens setting before starting the render as these settings need to be calculated for each image update in the main render window. This will add extra render time and also increase RAM usage during rendering, especially for high resolution renders. Instead, wait until the render has reached an acceptable SL for viewing the Simulens effect, stop the render, apply a Simulens effect to give you an idea of its influence,*

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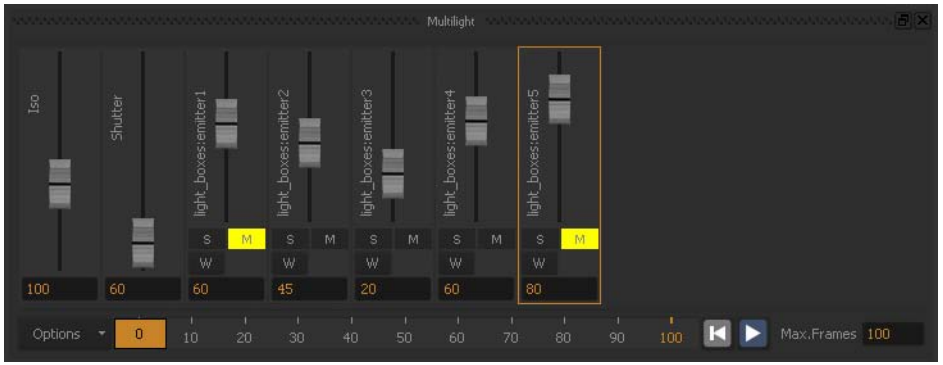
then disable the Simulens again and resume the render. For adding Simulens effects to a range of MXI files after the render is completed, use File>MXI Batch Processing. This tip does not apply to the Devignetting effect which does not use more RAM or calculation time, you can enable it before starting the render

- **Devignetting:** Vignetting is an artifact that darkens an image around the edges due to camera optics. The Devignetting slider removes the vignetting effect partially or completely by dragging it from 0 to 100%. In the real world, the more wide-angle the lens is (for example, a focal length of 24mm), the more pronounced the vignetting will be. As you raise the focal length of the camera, the vignetting effect will be less pronounced. A focal length of around 80mm or higher will have almost no vignetting, no matter the Devignetting settings used.

9.04 The Multilight™ Tab



F.01 Multilight™ Tab

Multilight™ is a unique and very useful feature that allows you to interactively adjust the intensity and/ or color of the emitters in the scene and to alter the ISO and shutter speed during rendering or after the render has finished. The adjustments can be keyframed and animated over time, and a sequence of images can be saved. Users can save different images of the same scene under different lighting conditions or make lighting animations from only a single render.

Intensity vs. Color Multilight modes

New in Maxwell Render V2 is the possibility to adjust the color of an emitter, instead of only its intensity. The Color Multilight mode is separate from Intensity because Maxwell Render has to use more RAM while rendering to also store color adjustments per emitter. The amount of RAM usage depends on the rendering resolution and number of separate emitter materials in the scene (which will determine the number of sliders you will have in Multilight). If your computer does not have enough RAM to render in Color Multilight mode for a particular render, you can switch to Intensity mode, or lower the rendering resolution and/ or reduce the number of separate emitter materials in your scene. Please note that changing the color of IES emitters is currently not supported.

You can even choose between exporting all the emitters´ contribution to independent images (Separated), or saving only the composed render (Embedded).

☑ *Note: The Color Multilight feature and the Shadow Channel exportation are incompatible, so if both features are enabled together the render will be stopped and an error message will appear in the Maxwell console.*

F.01 Multilight example images

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The Multilight™ tab has an Emixer, where you can adjust the intensity of the lights and the ISO and shutter speed. Each emitter in the scene is represented by a slider with the name of the emitter, including the Sky (any of the available Sky options) and IBL environment. The Emixer key-framed sequence can also be saved as an .emixer file. This is useful if you have several camera views of the same scene and you want to apply the same lighting conditions to other camera views.

- **Light Slider:** Controls the intensity of the light. It has an input where the exact intensity can be specified. Next to the input is the current unit of the emitter (Watts, Lumens, etc.)
- **S:** Solo button, will set the selected light as the only visible light, dimming all the others. Please remember that the Solo buttons work like the sliders of an audio sequencer. For example, if you have 20 lights in the scene, you can choose to Solo two lights. This is easier than having to mute 18 lights if you only wish to see the influence of two of the lights.
- **M:** Stands for "mute" and will switch off the current light source.
- **Color chip:** In Color Multilight mode, a color chip will appear underneath the slider allowing you to change the color of the emitter.
- **Max Frames:** Maximum number of frames in the Emixer timeline.

9.04.01 File Options

- **Load Emixer data:** Load an emixer sequence file in .emixer format.
- **Save Emixer data:** Save an emixer sequence file in .emixer format.
- **Save sequence:** Save a sequence of images which can then be made into a video using a video editing application. Transitions are animated within core rendering application.

> ☑ *Note: The .emixer file is an ascii format that you can directly open with any text editor to read and/or edit it, allowing you to easily change the intensity and color of each emitter at each frame, to adjust the lights animation to your needs.*

9.04.02 Edit Options

- **Create keyframe:** Create a keyframe at the current frame.
- **Delete keyframe:** Delete the current keyframe.
- **Autokey:** When checked, a keyframe will be generated automatically at the current frame if any adjustments are made to the emitters or ISO/ Shutter speed sliders
- **Copy:** Copy the current keyframe.
- **Cut:** Cut the current keyframe.
- **Paste:** Paste the current keyframe.
- **Toggle Solo:** Toggles the state of Solo emitters to Mute.
- **Toggle Mute:** Toggles the state of Mute emitters to Solo.
- **Change slider range:** Allows you to increase/ decrease the range of sliders for more control.

9.04.03 View

- **Disable preview:** When animating lots of emitters, it may slow down the playback of the time line with Preview On.
- **Layout Horizontally:** Switch to a horizontal layout of the Multilight sliders.

9.04.04 Animated Timeline

- **Creating a Keyframe:** Change the slider to set a keyframe at the desired time. Right-click on the slider, set the keyframe and adjust light values or turn them on or off.
- **Deleting a Keyframe:** Go to the keyframe you want to delete. You will notice it is a keyframe because the slider will turn orange. Right-click on the slider and choose Delete Keyframe.

9.04.05 Playback Controls

F.01 First frame | F.02 Play | F.03 Pause | F.04 Solo and Mute status

- Begin: Go to the beginning of the timeline.
- Play: Play the sequence (preview) or press Space bar.
- Pause: Pause the animation or press Space bar.
- S/M: Toggle status of all emitters: invert "solo" and "mute" status of emitters.

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9.05 The Right-click Menu

Right-click in the Display Render window to get access to the Display Options menu.

It allows you to Pan and Zoom in on the rendered image, rotate it, display it in Full Size, show/ hide the UI panels, and enable/ disable the displayed render.

9.06 The Console Tab

This panel provides information about the rendering process and scene statistics. Any error or warning messages are also displayed in the Console tab. If your scene does not start to render, you should first look in this panel for information on what the problem might be.

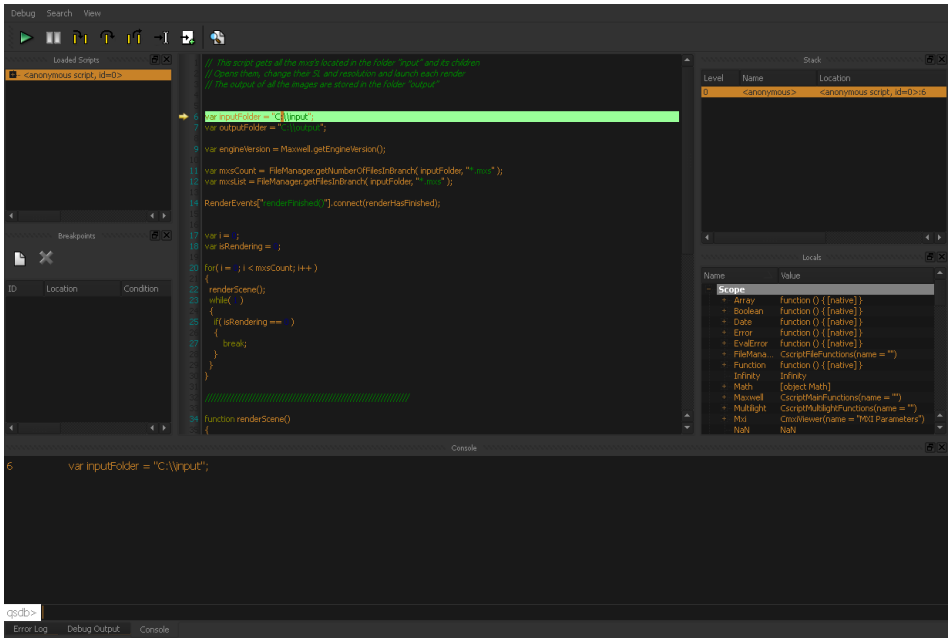
The verbosity levels can be controlled via the command line, using the -v: or -verbose: flag, which values can vary from:

- -v:0 (no information displayed)
- -v:1 (errors)
- -v:2 (warnings)
- -v:3 (info)
- -v:4 (all)

9.07 The Script Tab

The core rendering application now supports scripting. Scripting makes it much easier to automate tasks such as processing several MXI files at once, editing Multilight™ in animations, or launching sets of scenes changing their render parameters. All the parameters of the Maxwell Render UI are accessible through scripts.

The Maxwell Render scripting engine is based on ECMA standards (like other popular scripting languages such as Javascript and Actionscript), and provides default compatibility with these standards. The script editor in Maxwell Render also contains a Debugger, including breakpoints, searches, info about the variables, and more.



F.01 Debugger screenshot

Write a script in a simple text editor, save it with the .ms extension or even with the .js extension, and run it in Maxwell Render using the Run Script button in the Render Toolbar. It is also possible to launch a script through the command line using the argument -script:[script_path], or to directly write a script in the Script Editor in the Script Tab.
You can choose between several example script pre-sets for the most common tasks. These script pre-sets are available from the main menu (Scripting menu\ Scripts).

The Script panel shows a number of icons:

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- **Load Script File:** Load a script file in .ms or .js format and open it in the Script Editor. Script files can be drag and dropped to the Viewer area or to the Script Editor to load them.
- **Save Script File:** Save the current script in .ms or .js format.
- **Run Script:** Run the script currently open in the Script Editor.
- **Debugger:** Open the script Debugger window.
- **Find:** Find a word in the script.
- **Undo and Redo:** Undo or Redo the last changes in the script.

9.07.01 Autocomplete

When writing a script, the autocomplete feature offers easy access to the main functionalities. When typing the keywords "Maxwell", "Scene" or "MXI", the Script Editor will display a dropdown list, giving you access to all the available commands to control the Maxwell engine, the scene settings or the MXI settings respectively.

Example
This simple script accesses all the MXS scenes in a folder and its subfolders, changes the scenes' render settings, renders them and saves the output image in the specified location. You can change the commands and use the autocomplete help to explore all capabilities.

```
// These lines are comments – Make massive changes in MXS files and launch them to render
// This script allows you to access all the MXS located in the folder "inputFolder" and its subfolders
// Open the scenes, change their SL and resolution and launch the render(s)
// The output of all the images is stored in the folder "outputFolder" in Tiff format.
```

```
var inputFolder = "C:\\ set the input folder";
var outputFolder = "C:\\ set the output folder";
var engineVersion = Maxwell.getEngineVersion();
var mxsCount =  Maxwell.getNumberOfFilesInBranch( inputFolder, "*.mxs" );
var mxsList = Maxwell.getFilesInBranch( inputFolder, "*.mxs" );
for( var i = 0; i < mxsCount; i++ )
{
    var mxsFile = mxsList[i];
    Maxwell.print( "rendering Mxs file: " + mxsFile );
    Maxwell.openMxs( mxsFile );
    Scene.setSamplingLevel( 12 );
    Scene.setResX( 1024 );
    Scene.setResY( 768 );

   var imagePath = outputFolder + "\\" + Maxwell.getFileName( mxsFile ) + "_" + engineVersion + ".tiff";
    Scene.setImagePath( imagePath );

    Maxwell.startRenderAndWait();
}
```

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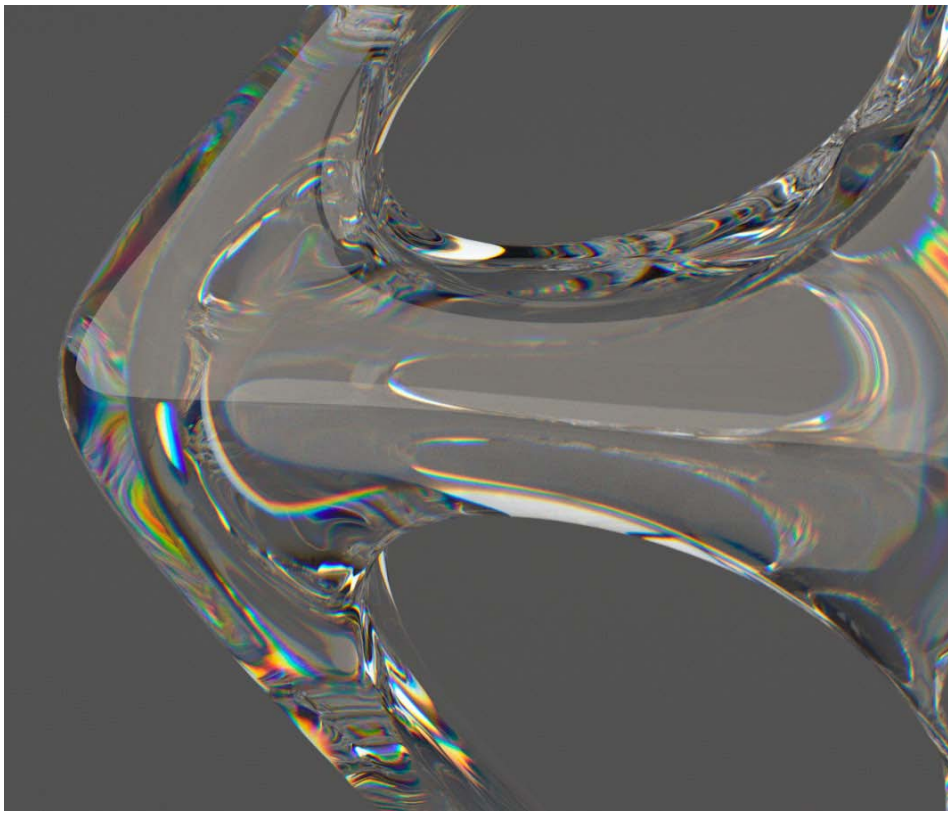

10 MAXWELL MATERIALS

10.01 Maxwell Materials

Before explaining the material parameters used in the Maxwell material system, it is important to have a basic understanding of what light is, how it interacts with materials and why a material looks shiny, dull, transparent etc. Please review this information as it will make the parameters in the Maxwell material editor much easier to understand.

What is light?

Visible light is really a very small portion in a range of electromagnetic radiation. This radiation travels in waves of different wavelengths. The difference in wavelengths (the "tops" of each wave) is what makes the difference between blue, red, gamma rays, x-rays, radio waves etc.

"White light" is a combination of all the colors in the visible light spectrum. When we perceive an object as red for example, what really happens is that white light falls on a red surface, and all the wavelengths except those that give red light are absorbed by the material. Only the red portion of the spectrum is reflected back.

Diffuse – Specular & Reflected light
We see an object because light is reflected from its surface into our eyes. That is, ALL light is reflected light. This may sound confusing at first because it has become common in renderers to refer to reflected light as specular (or sharply) reflected light.

In the real world light does not have a separate "diffuse" or "specular" part. So what makes a surface look dull, or mirror like? It is the smoothness of that surface.
A surface which is not very smooth has tiny imperfections which scatter the light in all directions, thus creating a very "diffuse" reflection of its environment. So it is the reflection of light from an uneven or granular surface, resulting in an incoming light wave being reflected at a number of angles.

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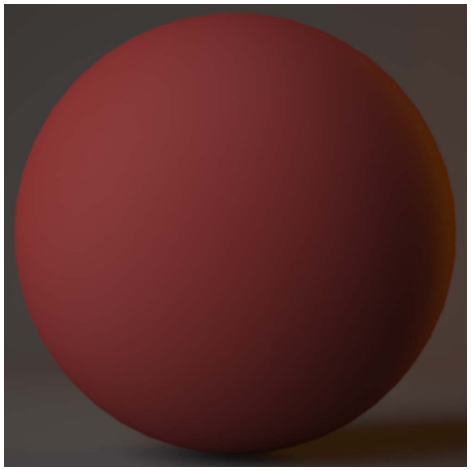
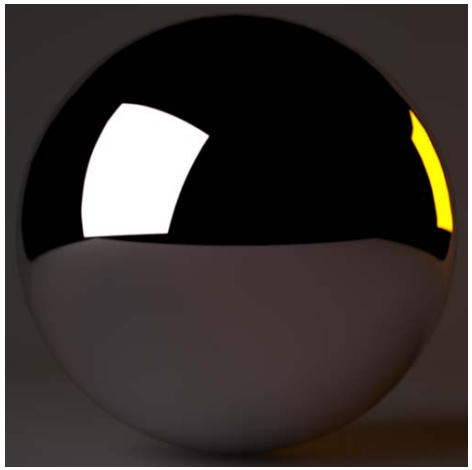
A surface which scatters almost all light in a chaotic, diffuse way is called a "lambertian" surface, such as the red ball on the left. Lambertian reflectance means that light falling on a surface is scattered in such a way that the apparent brightness of the surface is the same, regardless of the observer's angle of view. Or else: the surface's luminance is the same regardless of angle of view. Many rough surfaces, such as unfinished wood, exhibit lambertian reflectance.

A surface which scatters almost all light in a chaotic, diffuse way is called a "lambertian" surface, such as the red ball below (F. 01). Lambertian reflectance means that light falling on a surface is scattered in such a way that the apparent brightness of the surface is the same, regardless of the observer's angle of view. Or else: the surface's luminance is the same regardless of angle of view. Many rough surfaces, such as unfinished wood, exhibit lambertian reflectance



F.01



F.02

A smooth surface however reflects light uniformly and creates a very sharp or specular reflection of its environment. Specular reflection is the perfect, mirror-like reflection of light from a surface, in which light from a single incoming direction is reflected into a single outgoing reflection, as for example with a mirror.

It is important to note that because very smooth surfaces reflect light perfectly, they reflect much less of their own color. This is visible in the render (See above F.02), where the ball is still tinted red, but as it is a tinted mirror, its own color shows much less. There are a few exceptions however and one of them is metals. Even if a metal is very smooth, it still reflects its own color much more.

Transparency

An object becomes transparent when light does not stop at the surface, but goes through the object and out the other side. When light passes through a material, it slows down because the material is denser than vacuum. Because of this change in speed, the light is bent, or refracted, when going from vacuum (or air) into the material. This refraction occurs whenever light changes speed, so it happens when it moves from one material to another with different densities. The refraction is also what causes "caustics": concentrated pools of light.

In the render below (F.03), it is refraction that makes the magnifying glass distortion, and creates the caustics pattern. Different materials make light slow down more or less, relative to the speed of light in air or vacuum. This difference between lightspeed in vacuum <–> lightspeed in medium, is specified as the index of refraction (IOR, also called Nd) for that particular medium.

F.03

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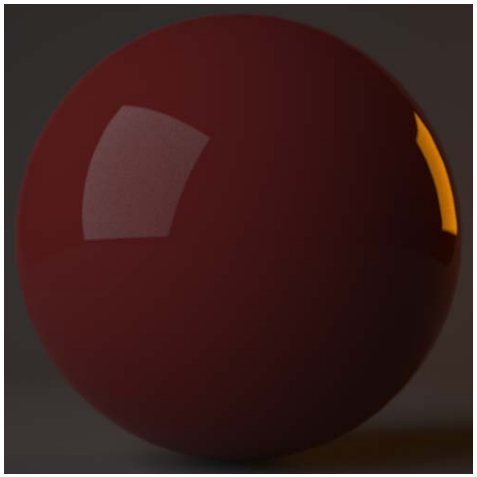
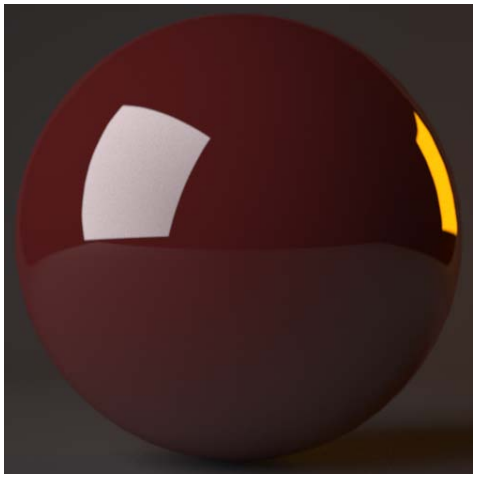
The Fresnel Effect
The Fresnel effect is the apparent increase/ decrease of a surfaces reflectance based on viewing angle. For example, if you look at your monitor screen straight on, the monitor glass shows almost no reflection, but if you look at it from an angle almost parallel to the glass, it has become very reflective. The Fresnel effect is dependent on the Nd of the material. The higher the Nd, the more reflective the material becomes at ALL angles, so the Fresnel effect diminishes – the material becomes equally reflective at all angles. It is important to understand this effect in order to create realistic materials. A plastic material for example should not have the Nd (Fresnel) set too high or it would become unrealistically reflective, even when viewed straight on. It would behave more like a metal than a plastic.



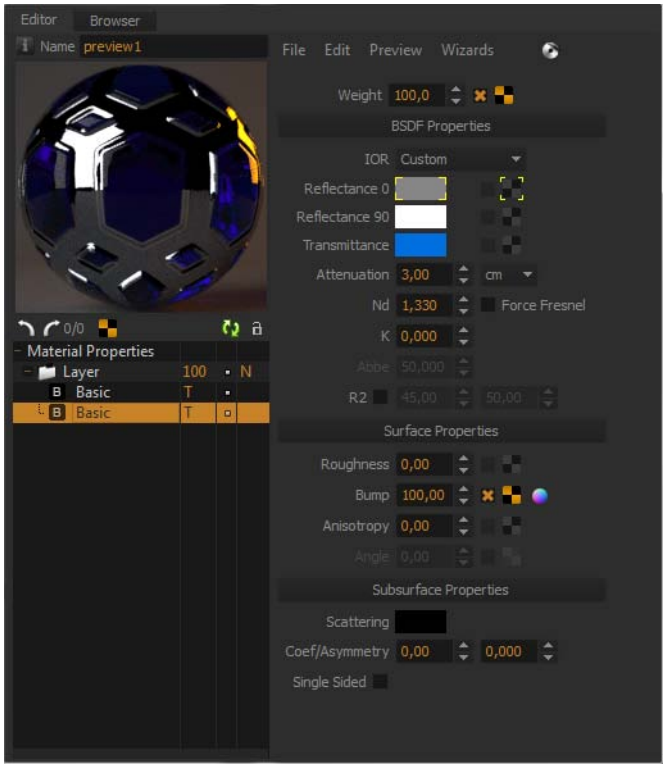
F.04 Nd=1.6



F.05 Nd=30

10.02 The Material Editor (MXED)

The material editor is one of the most important components of Maxwell Render™. It provides a powerful set of parameters for advanced editing of a Maxwell material. The five main areas of the material editor are:



F.01 The Material Editor

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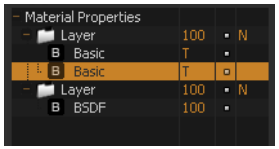
a. Material Components

Maxwell Render's materials are made up of different "components" which are organized into folders. A folder can hold one BSDF (Bidirectional Scattering Distribution Function) component and Coating, Emitter and Displacement components.
Each folder in the material editor represents a Layer, which are stacked one on top of the other, similar to layers in a 2D image editing application. Please see the chapter about the Stacked Layers system for more information.



F.01 Material components

b. Material Preview

F.01 Material preview

This window allows you to get a quick preview of the material while you are editing it. When you are changing your material parameters, double-click in the preview sample image to refresh the preview with the new parameters, or click on the Refresh Preview button (green double-arrow icon), and Maxwell Render will compute a preview of your material. During the preview, the green icon will be replaced by a red square icon, to indicate that it is calculating your preview.

c. BSDF Properties

Parameters to control the main optical properties for each material component (BSDF, coatings, etc).

F.01 BSDF properties

d. Surface Properties

F.01 Surface properties

Parameters to control the surface properties of a material.

The material components section also contains various buttons to control the aspect of the material and material editor.

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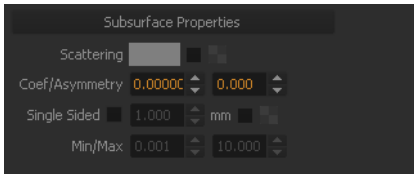
e. Subsurface Properties

Parameters to control the subsurface scattering (SSS) properties of a translucent material.



F.01 Subsurface properties

10.02.01 File Menu

- **New MXM:** Create a new material.
- **Open MXM:** Load a .mxm file. The material will be loaded into the material editor as well as added to the scene material list (if Maxwell Studio is used).
- **Export MXM:** Export the currently loaded material as a .mxm file.
- **Description:** Add a short description of the material.
- **Texture List:** Opens the textures panel which displays all the textures used in the scene with different information about them (name, bit depth, resolution, type, path).
- **Fix Texture Paths:** This function allows you to choose a folder containing MXM files and fix the texture paths used in the materials found in that folder (and subfolders) to avoid a "textures not found" error while rendering. For example, a material you have downloaded from the MXM Gallery might contain the paths to the textures used in it relevant on the computer of the user that uploaded the material, but they will no longer be valid on your computer. The Fix Texture Path function will go through the following searches to look for the textures, in order:

  - in the same folder as the MXM
  - in the same folder as the MXS file
  - in the Textures paths that you have set in Preferences> Materials> Textures.

  When it has found the textures it will write the new path in the MXM file and save it
- **Extract from MXS:** If using MXED, you can choose a .MXS file and extract all the materials in that scene to a folder of your choice. When using Maxwell Studio, it will extract the materials from the currently loaded scene.

10.02.02 Edit Menu

The options in the Edit Menu are the same ones that appear when right-clicking in the material components section.

10.02.03 Preview Menu

The options in the Preview Menu are the same ones that show up when right-clicking in the material preview section.

10.02.04 Wizards Menu

The Wizards Menu is a step-by-step guide to creating different types of common materials, such as shiny wooden floor, plastics, clipmapped materials for leaves, subsurface scattering materials, and more. The Wizards will ask you for textures, bumps, reflectance maps and material values such as roughness and color, guiding you through the process of creating materials.

10.02.05 The Material Preview window

This window shows a preview of the current material. To preview a material, click on the Refresh Preview icon, or double-click on the preview image.

The Material Editor also has **Maxwell Fire** capabilities, giving you a constant interactive preview of your material.
To enable **Maxwell Fire** on your Material Editor, simply press the lock icon. While this icon remains locked, your preview will be fully interactive, displaying the changes in the material in real time, providing you with an extremely precise control over the material you are creating.

Two different qualities are available for this interactive preview: Draft and Production quality.
You can also set the rendering time and sampling level for the material preview.
These preview options (including the preview sample scene used for rendering the material) are accessible by right-clicking in the preview sample image or from the Preview menu in the Material Editor.

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F.01 Material preview

By right-clicking on the material preview image or using the Preview menu in the Material editor, you can access some specific options:

- **Select Scene:** You can use any MXS file to preview your materials. By default Maxwell Render uses the defaultpreview.mxs file in the preview folder of your Maxwell installation folder. The list shows all the scenes found in this folder.
- **Load Scene:** Load a scene to use in the material preview.
- **Previews:** This dropdown will list all the saved material swatches. Each swatch will have a small preview and you can select it from the list to revert the material settings to that swatch. Alternatively, you can use the Browse swatch button at the bottom of the Preview section.
- **Store:** Store the current material settings as a swatch. The saved swatch will save all settings from the entire material, including if a texture is activated or not, texture tiling, etc. Please note that these swatches are saved temporarily and will not be available when you re-open the scene.
- **Remove:** Remove the currently selected swatch.
- **Export:**
  - **To MXS:** Export the currently selected swatch to the current scene and add it to the material list.
  - **To MXM:** Export the currently selected swatch to a new .mxm file.

  ☑ *Please note: these two options will only work if you have a saved swatch in the material.*

- **Options:** This field specifies the quality and the size of the material preview. Complex materials may require a higher Sampling Level. Use this filed to specify the SL, Render Time and Scale of the material preview. These options are also available in the Preferences panel, and they will be used as defaults.
- **Making your own preview scenes**: The material preview window can render any MXS. Preview scenes are useful to preview specific scenes or objects. When the Right-click menu is open, all the MXS files available in the preview folder are shown, allowing you to choose the one you need. Create your MXS scene as usual, but make sure the scene has a material called "preview" applied to the object(s) you want to use for material previewing. Then save your MXS in the preview folder located in the Maxwell installation folder.

  ☑ *Tips for creating preview scenes*

  - Keep the scene as simple as possible, with few emitters and without using heavy geometry. This way the preview will start and render faster.
  - Make sure the object with the preview material has UVs applied to it; otherwise you will get an error trying to preview a material that uses textures.
  - Keep an eye on the scale of your preview scene and the scale of your preview object. For example, if your preview object is 2cm in size and the camera in the scene is close to the object, and you are trying to preview a displacement material set to use an absolute height of 50cm, the preview will take a very long time to start. In addition, the preview might look completely black because the displacement has actually gone past the camera – it sees the "inside" of the object.

10.02.06 The Right-click Menu

Right-click in the panel of the material component tree to display the main tools. You can access the same tools through the Edit menu in the Material Editor. The following menu appears:

- **Add Layer:** Add a new layer to a material. The layers work like different materials stacked one over the other in a layered object (i.e.: a shiny layer of paint over a wood surface). Each layer represents a complete material, with as many BSDF components inside as you like. Please see the Stacked Layers system description in Chapter 10.3 for more information.
- **Add BSDF:** Add a new BSDF component to the current layer. You can add as many BSDF components to a layer as you like.
- **Add Emitter:** Add an emitter component. Emitters can be mixed with a material. For example, if you have applied a glass material to a light bulb with the emitter turned

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on, it will shine light on the scene just like a regular emitter. But when the emitter is turned off, it will reveal the glass bulb material. You can apply only one emitter component per layer.

- **Add Coating:** Add a new coating to the selected BSDF. You can only add one coating component per BSDF.
- **Add Displacement:** Add a displacement component to the current layer. Please note that, although you can have multiple displacement components in a multi-layer material, only one of them will be used for rendering. You can specify which one you would like to use for rendering by clicking on the Material properties tab. For more information, see the Stacked Layers system description in Chapter 10.3.
- **Copy-Paste-Duplicate-Rename:** Select the component of your choice and use this function to copy, paste, duplicate or rename the component.
- **Embed MXM:** Import a MXM into the current material. The layers of the new material are added to the current material.
- **Reset Selected:** Restore the parameters of a selected layer or component to default.
- **Remove Selected:** Delete the currently selected layer or component. You can click on the folder icon to delete all the components in the layer, or click on an individual component to delete just the selected component.
- **Remove All:** Remove all the layers or components from the material.

10.02.07 The Color Picker

The Material Editor Color Picker is a simple and fast tool for choosing colors. The small circle on the outer colored wheel lets the user rotate the triangle inside, choosing the hue. The second circle allows you to choose value and brightness within the hue selected. You can also specify the color in HSV, RGB or XYZ coordinates, using the "radio buttons" below the chromatic graph.

The color chips on the right side can be used to store commonly used colors. Drag & drop a color from the large color chips at the bottom of the Color Picker to one of the color chips on the right to store a color.

The two large color chips at the bottom of the color picker allow you to compare the previously selected color with a new one. The left color chip updates to show the currently selected color in the colored wheel. The right color chip shows the previous color that was selected when the Color Picker was opened.

10.02.08 The Texture Picker

Clicking on any texture icon will bring up the texture picker, which allows you to load a texture.

- **Loading textures:** To choose a texture, click on the Load button or drag & drop a texture from any Explorer or desktop window into the main frame. You can drag & drop multiple textures at once. The textures will become available for selecting in the dropdown menu.
- **Unloading a texture:** Select a previously loaded texture from the dropdown menu and click the Unload button to remove it from the scene. This will free up some memory.
- **Full View:** View a texture in full size. You can also use the image control sliders in the full view window, although the texture will not update in real time. It will update after you have made a change.
- **Refresh:** Reload a texture in case you have edited it in an external image editing application.
- **Switch Display Size:** Switch the thumbnail texture view to a small or a large preview for easier viewing of texture changes.

There are also several parameters to control the Projection Properties and Image Properties.

The application of a texture can be controlled through the Projection Properties:

- **Channel:** Specify the UV set to be used for this texture. In Maxwell Studio a "UV set" is a set of UV coordinates for an object. One object can have several UV sets. If an object has only one UV set applied to it, that UV set will be numbered 0. If an object has two UV sets applied to it, they will be numbered 0 and 1. For example, imagine you have an object with a Cubic and a Spherical UV set, and the Cubic UV set is numbered 0 and the Spherical UV set is numbered 1. You may want to map some of the textures to the object using the Cubic UV set, and some other textures using the Spherical UV set. Given the Cubic UV set belonging to the object uses channel 0 (you can check which channel number it uses in the Object parameters panel in Studio, under the UV Sets section), you should set the channel number to 0 so that the particular texture will be mapped using the Cubic UV set.
- **Method:** Tile your texture in X axis, Y axis, both the X and Y axis, or do not use any tiling at all (no repeat).
- **Repeat:** Specify the tiling amount (number of repetitions of the texture) in the

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desired axis.
- **Offset:** Select the amount of offset for the X, Y axis.
- **Relative/ Meters:** The amount of tiling for a texture can be set in the texture coordinates (Relative), or in real scale in meters (Meters). Maxwell Render will use a 1m x 1m x 1m UV set for the texture when the Meters option is selected, regardless of the actual size of the object and what other UV sets may be applied to the object. This is very useful to create re-usable materials which can simply be dragged & dropped on an object of any size. For example, if you want to create a material with 25cm tiles, check the Meters mode, and set the tiling for both X and Y axis to 0.25. Now you can drop this material on a floor of any size and your tiles will always be 25cm.

The Image Properties section is an image editor where you can make simple adjustments:

- **Invert:** Invert the loaded texture. This is useful for black & white textures used as a weightmap or mask.
- **Interpolation:** Turning this option on applies filtering to a texture, which may be useful to avoid pixelization when rendering close-ups of smaller textures. Filtering is handy mostly for displacement textures – to smooth out the displaced surface – especially when using 8bit textures. It is recommended to keep this option turned off for regular textures (color, bump, weightmaps, etc.) to avoid blurring them.
- **Brightness/ Contrast/ Saturation:** Common image editing options useful for fine-tuning a texture without having to use an external image editing application.
- **RGB Clamp:** Adjust the levels of your image. This function enables you to specify the maximum darkest or brightest values in the texture. For example, if you change the min Clamp from 0 to 30, any value in the texture darker than RGB 30 will be set to 30.

10.02.09 Drag & Drop functionalities

The Material Editor has certain drag & drop functions. You can drag & drop:

- Color chips
- Texture icons

By default both textures and texture settings (tiling, offset, etc.) are copied. Hold Shift before starting the drag & drop to only copy the texture itself.
The drag & drop functionality also works between BSDFs – you can drag a color chip or a texture icon from one BSDF to another. To do so, start dragging the icon over a BSDF layer icon. The right side of the material editor will change to show the BSDF properties. Now you can drop the icon in one of the appropriate slots.
You can also drag & drop a Layer to another Layer to rearrange them if you wish.
You may also replace the settings of one component with the settings of another by holding Shift and dragging & dropping one component over the other.

10.03 The Stacked Layers System

Maxwell materials work in a natural, layered way. A layer represents a complete material and it can (and usually will) contain several BSDF, coatings, displacement components, etc.
Each layer should be thought of as an independent material, and the different layers in a material are stacked from bottom to top, just like with the Photoshop layers palette. The top layers conceal the bottom layers, and this means that the order of the layers in the material arrangement can change the material's look and behavior completely. This makes it easy to create complex materials. In real life, there are many surfaces that are created putting different materials over one another, like paint over wood, a decal over a metal surface, or dust over a glass surface.

To allow maximum control over all the properties of a material, the material parameters have been arranged into three different panels, accessible from the layers list:

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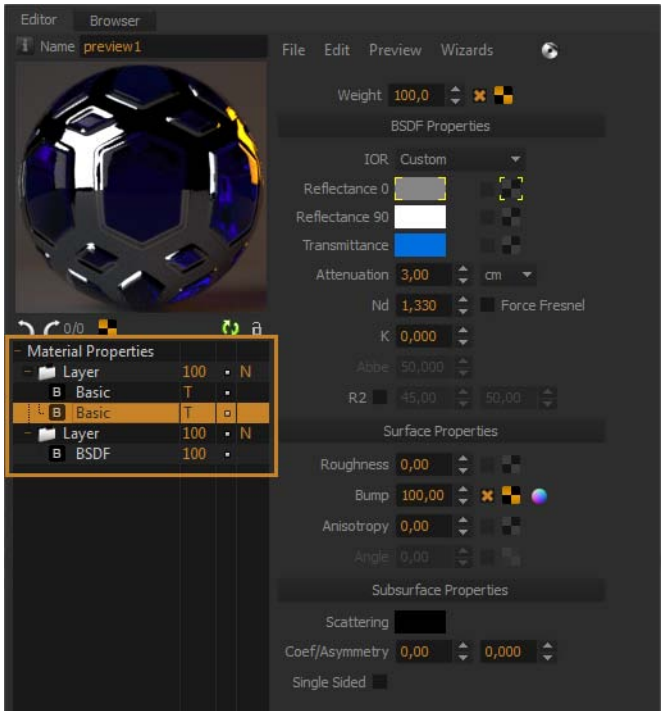
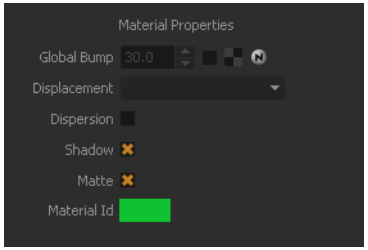


F.01 The Stacked layer system

10.03.01 Material properties



F.01 Material Properties

Click on this row to get an overview of the parameters that can be applied to the whole material.

- **Global Bump and Normal map:** You can specify a global bump/ normal map which will affect the whole material, alongside the bump of each individual BSDF.
- **Global Displacement:** Allows you to specify which displacement component belonging to a Layer should be used when rendering. Even though you can apply one displacement component per Layer, only one of them will be used for rendering.
- **Dispersion:** Enable/ disable the dispersion calculations. For more information about dispersion see the Abbe section of the BSDF Properties chapter.
- **Shadow and Matte:** Enable/ disable the shadow catcher and matte properties for this material. Special features chapter shows an example of the use of these two properties for compositing purposes.

10.03.02 Layer properties

Click on a Layer folder to set the parameters that affect each particular layer. You can set the layer opacity, use a texture mask, or set the blending mode to control the blend of this layer with the layers underneath it.

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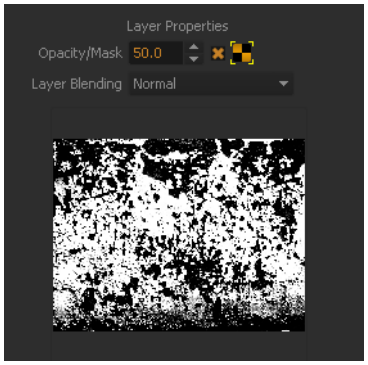

F.01 Layer Properties

- **Opacity/ Mask:** Set the value of the opacity, or use a grayscale texture mask to control the visibility of this layer. Black stands for zero opacity, and white stands for full opacity. The texture preview window below allows you to display the image mask used in the current layer.
- **Layer Blending:** Choose between Normal and Additive mode to blend the current layer with the layers below.

  If the Layer is set to Normal mode it will act like a "solid" Layer, and it will be stacked as a real material on top of another Layer. So if the Layer blending mode is set to Normal and its opacity is 100, no layers underneath this Layer will be visible. For example, if its weight is set to 50, it will act as a semi-transparent material that is on top of the layer(s) underneath it.

  Additive mode however takes the material properties found in the components of the layer (the color, reflectance of any BSDFs, coating etc) and multiplies those values with the layers underneath it, much like the "Screen" layer blending mode in Photoshop. This means that even if the layer's weight is set to 100, in Additive mode the layers underneath it will still be visible. The Additive mode has the overall effect of brightening the material. When the layer in Additive mode is brighter, the colors of the layers underneath it will get brighter. When the Additive mode layer is fully black, no change occurs in the layers underneath it. When the Additive mode layer is fully white (a strong reflection) everything underneath it also becomes fully white. A good way to visualize this effect is thinking of projecting light through several photographic slides. It can be useful to create interesting blends between the textures used in the BSDFs of the different layers and also to create plastics that have a thin shiny coating on the surface that still allows the color of the plastic to show through beneath it.

- **Working with Layers:**
  - You can rename a layer by double-clicking on its name.
  - You can re-arrange the stacking order of the layers by dragging and dropping them up or down in the layers list.
  - You can also collapse and expand the content of each layer.
  - Each layer shows a range of specifications in the columns next to it. The first column shows the layer's opacity in percentage and a "T" in case the opacity of this layer is controlled by a texture. You can also double-click on this setting to change it. The second column allows you to enable/ disable the layer. The last column shows the blending mode of this layer with the layers underneath. You can also click on this value to switch between Normal "N" mode and Additive "A" mode.

Some things to keep in mind when working with the new Stacked Layers system in Maxwell Render 2:

- Because each Layer has an opacity control which controls the influence of that Layer, your material can look transparent if the Layer weight is below 100, even if a BSDF inside the layer is set to weight 100. This is true also for multiple Layers. For example, two Layers with their weight set to 50 will also create a transparent material. In other words, the Layer weight controls the opacity of all the components inside it, no matter what the component weights are set to.
- It is much easier to create variable transparency materials with Stacked Layers than with the previous material system. All you have to do is texture the Layer weight with a grayscale map.
- It is also much easier to create clipmaps; just apply the clipmap to the Layer weight.
- Many materials that were impossible or very difficult to create in Maxwell Render 1.7 are now possible, such as multiple emitter layers which can be mapped using variable transparency for some interesting effects; or a complex car paint material containing several BSDFs on top of another material, simulating rust, which in itself can also consist of several BSDFs. The organization into Layers makes all this easy to create.

See Appendix I for an easy step-by-step guide to create some basic materials.

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10.03.03 Specific properties

When selecting a material component in the layer tree (a BSDF, a Coating, an Emitter or a Displacement component) its properties will appear in the right area of the Material Editor. These components form the foundation of the Maxwell material system, and they are explained in the following chapters.

10.04 The BSDF

The BSDF component is the main component in the Maxwell material system. It contains all the parameters needed to create lots of different types of materials, ranging from clear glass to sandblasted glass, plastics, metals and translucent materials such as skin, porcelain, and wax. In this first section we will go through each parameter in order, providing brief descriptions. In the second section we will show different material examples and discuss the settings used.
When a BSDF is selected in the material layer, the BSDF properties are displayed in the panel on the right hand-side. The controls are divided into 3 distinct areas: **BSDF Properties**, **Subsurface Properties**, and **Surface Properties**.

The BSDF properties handle all settings related to the material as a whole. The Subsurface properties control the effect of translucency – or light that is scattered beneath the surface. The Surface properties handle all settings related to the surface of the material, such as the surface roughness and bump.

10.04.01 BSDF Properties

Reflectance 0º / 90º

F.01 Texture slot

This is the light reflected by the material. In other words: it is the color of the material. Choose a reflectance color by clicking on the Color Picker, or specify a texture by clicking on the Texture slot (image above). You can enable or disable the texture using the check button near the Texture slot.
A full white reflectance (RGB 255) means that all the light that falls on the object is reflected back. Black reflectance (RGB 0) means that all the light is absorbed. Please note that the reflectance colors describe the amount of light the object reflects back, but not how that light is reflected back (in a diffuse way, or a specular way for shiny objects). This is instead controlled by the Roughness parameter. See the Surface Properties chapter which describes how smooth or bumpy the surface is.

There are two reflectance colors: the light reflected when the object is seen at 0º degrees (frontal view) and at 90º degrees (glancing angle). The Reflectance 0° is the object's main color. The Reflectance 90° color (also called Fresnel color) is the object's color at glancing angles. This is useful when you have a material which reflects one color when viewed straight on, but at sharper viewing angles reflects another color, such as taffeta, silk, and velvet. Think of the Reflectance 90° color as the object's "specular" reflection.

How much influence the Reflectance 0° color vs. the Reflectance 90° color has on the look of the material depends mostly on the roughness settings and to a certain degree on the Nd. You can find more information on these two parameters and how they affect the influence of the Reflectance 0° vs. the Reflectance 90° colors in the following chapters.
For most materials, the Reflectance 90° color is white. However, materials like metals usually have tinted reflections. For example, if you would like to create a golden material, you should set the 0° color to a yellowish tone and then use a brighter yellow for the reflection 90° color so that the specular reflections become tinted as well. Changing the Reflectance 90° color allows for different reflected colors at the edges of the object.

> ☑ *Important: Avoid setting the Reflectance 0° color too bright. Setting it to 255 for example means this material will reflect back almost all the light it receives, which does not happen in the real world. Maxwell Render still keeps the amount of light reflected/ absorbed within physical limits but the result with such high Reflectance values means the light will keep bouncing around in your scene with very little loss in energy, which will produce noisier renders and a washed-out look with very little contrast. A reasonable setting even for very bright materials would be around 230-240. For example, the Reflectance value of a white piece of paper, when converted to RGB, is around 225. Please note that this only matters for the Reflectance 0° color. The Reflectance 90° color can be left at fully white (RGB 255).*

Transmittance
This parameter controls the color of the light when it passes through a transparent

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material. Choose a Transmittance color by clicking on the color picker, or specify a texture by clicking on the texture button. The Transmittance color represents the color of the light when it has reached the Attenuation distance (see below).

> ☑ *Note: Transmittance must be a color other than black for transparency to appear. Setting a brighter transmittance color results in clearer transparency, but you should remember that this parameter is also tied to the Attenuation Distance.*

Attenuation

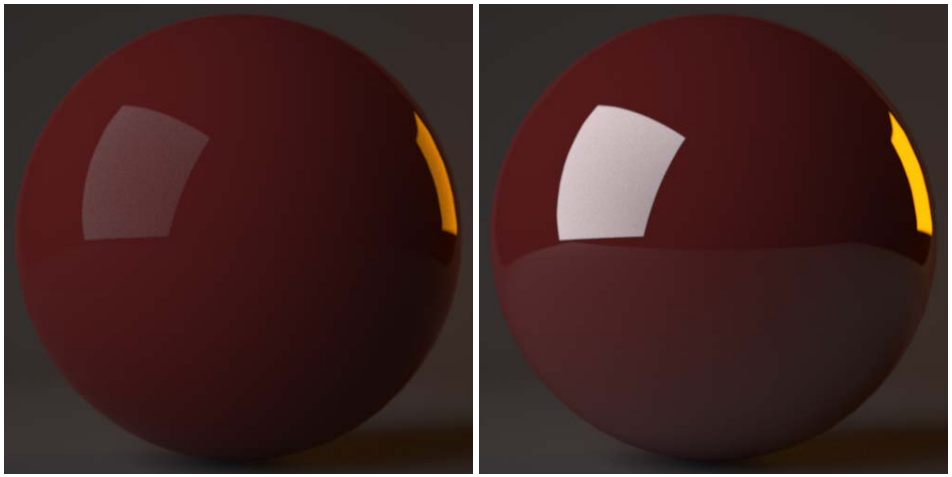
Glass, water, or even air are transparent when thin, but become opaque when a specific thickness is reached (different for each material). As light travels through a material, it loses energy. The Attenuation distance parameter allows you to specify how far light can move through an object before losing half its energy. For example, if you have a 2cm thick glass window and you set the attenuation distance to 2cm, the light shining through the glass on the other side will be half as bright.

Attenuation distance and Transmittance work together. You must set the Transmittance color higher than RGB 0 for the Attenuation distance to become active. If your Attenuation distance is very small (for example 1nm) the object will remain opaque because the light can only travel a very small distance into the object, and will not come out on the other side. On the other hand, if you have a 1cm thick glass window and you set the attenuation distance very high (for example 900 meters), and you set the Transmittance color to blue, the glass will not be colored blue at all. It will be completely transparent because there was not enough distance in the 1cm thick glass to cause any attenuation and reveal the Transmittance color.
Attenuation is ruled by an exponential curve, therefore: the thicker the object, the more attenuated the light will be.

To better understand the concept of Attenuation, consider sea water. When the water layer is very thin (like water in the palm of your hand) you do not see attenuation: the water looks transparent. When you have more water thickness, you see a typical sea color (grey, dark-blue or light blue-green, depending on deep or shallow waters). The Transmittance color represents the color that you want to get approximately at the Attenuation distance. Beyond this distance, the light is more and more attenuated, it loses more and more energy, and the view eventually turns opaque if the volume is thick enough.

Nd

Simply put, Nd should be regarded as the IOR (index of refraction) of the material. The name Nd is used because it is the common way to denote an index of refraction that has been measured at the wavelength of 583 nm.
Before explaining how Nd influences the look of a material, it is important to understand the "Fresnel effect". This effect states that the strength of reflections on a surface is dependent on the viewing angle. For example, if you look straight on at your monitor screen, you will see very weak reflections, but if you look at the screen at an angle, the reflections will appear stronger.



F.01 Nd=1.6 F.02 Nd=30

The relationship between Nd and the Fresnel effect is that with a higher Nd number the surface will start to look equally reflective, no matter the viewing angle. So in effect, a higher Nd "weakens" the Fresnel effect.

So changes in the Nd number affect the overall reflectivity of an object. For example, you can have the Reflectance 90° color set to full white, but with an Nd of 1 the object will have very weak reflections (F.03).
Setting the Nd to a high value like 40 and keeping the Reflectance 90° to that same full white color will result in a mirror-like surface (F.04).

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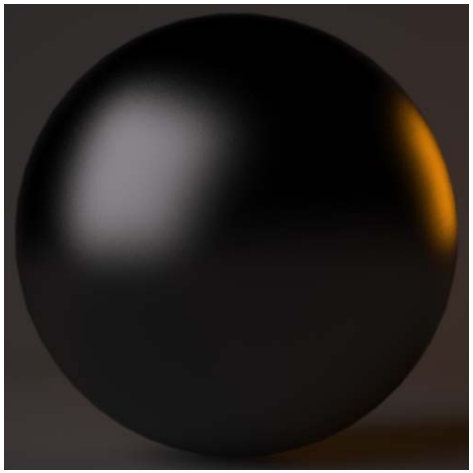
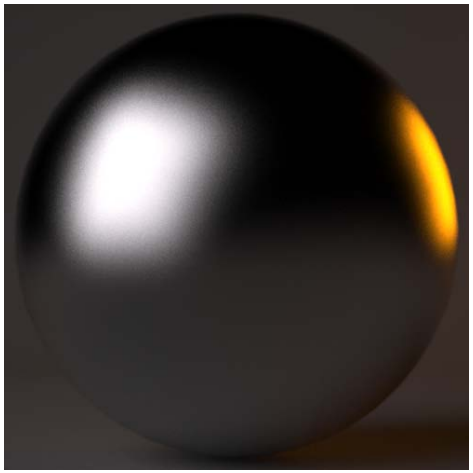
The following images demonstrate this:



F.03 Nd=1



F.04 Nd=40

From the images above you can see that raising the Nd increases the effect of the Reflectance 90° color, while the Reflectance 0° color (in this case set to nearly black) has less and less effect when increasing the Nd.

Of course the value of the Reflectance 90º color will also affect the maximum strength of reflectance. For example, you can set a high Nd but set the Reflectance 90° to a dark color. The result will be a surface which is reflecting equally, no matter the viewing angle, but the reflections will appear weaker.

For opaque materials, an Nd of at least 3 is recommended if you want them to be reflective. Metals have an even higher Nd. The Nd setting can go as high as 1000. For a mirror-like surface it is usually enough to set the Nd to 100.

The Nd has no influence on the look of the material when working with Lambertian materials. Lambertian is a special mode which makes a surface reflect all light in a diffuse way. A Lambertian material has a roughness 100. It is the highest roughness a surface can have. It is also important to remember that the Nd has less influence on the reflectance of an object the higher you set the Roughness (See the Surface Properties chapter for more details on the Roughness parameter). The smoother a surface is (low roughness), the bigger the effect of Nd on the surface will be. You will see the biggest changes to the reflectiveness of the object as you change the Nd, when the surface roughness is low.

With transparent materials the Nd also controls the amount of refraction. Seawater for example has an Nd of about 1.333. You can find common Nd values for transparent materials on the internet.

- **Force Fresnel:** The amount of light that is reflected back from the object is determined by the refl 0° and 90° colors. The Nd controls the Fresnel curve, or the influence of these two colors, depending on viewing angle. In reality however, the Nd itself specifies how much light is reflected back from the surface, with a higher Nd specifying a more reflective material. These three settings (refl0°, refl90°, Nd) can come into conflict when you put in, for example, a black refl 0° color but a very high Nd. Force Fresnel ensures that the reflectance ramp (curve) between Ref0 and Ref90 will be maintained by the given Nd. It discards the luminance of a given reflectance color and enforces physically correct Fresnel while only deriving the hues of the refl. 0° and refl. 90° color chips. When Force Fresnel is unchecked the reflectance value of a surface is derived both from the Nd and the luminance of the refl0° color. When Force Fresnel is checked, the reflectance between refl0 and 90° (the Fresnel curve) is maintained according to the Nd, and only the hue of a given reflectance color is taken in consideration.

  This option should be turned off when you texture the refl. 0° or refl.90° channels, otherwise your textures may not appear as you expect when using a lower roughness. As you can see in the images below, because the luminance information of a given color is discarded, a bright red in your texture may appear darker than expected if the Nd is low and the Force Fresnel option is checked. Here, Maxwell Render is determining the final reflectance of the object, just looking at the Nd.

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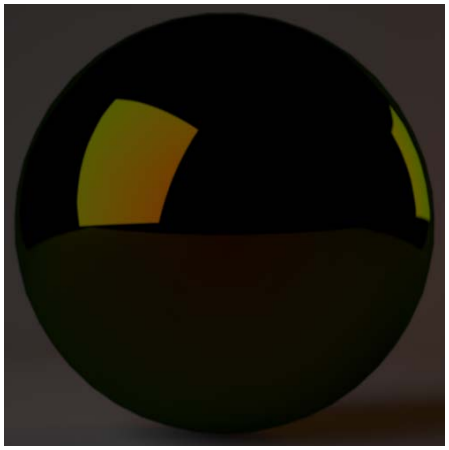
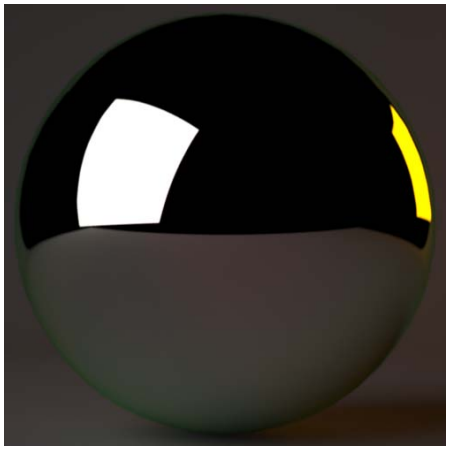


F.01 Nd=30



F.02 Nd=30 with Force Fresnel

F.03 Nd=30

F.04 Nd=30 with Force Fresnel

You should turn on Force Fresnel when you are working with untextured refl. 0° and refl.90° channels to create more realistic metals or other shiny materials. Force Fresnel will then ensure a correct reflectance across the entire surface, even if you set a very dark refl. 0° color.

K

From a physical point of view, the index of refraction is not just a plain number. In fact it is a number derived from a complex calculation to define the refractive index at one particular wavelength. This is the calculation:

```
Refraction at a particular wavelenght = Nd + K·i
```

The Nd represents the refractive index, which is the well-know concept of Index of Refraction we often use.

The K is the extinction coefficient: the amount of absorption loss when an electromagnetic wave propagates through a material. This is usually confused with the Abbe, but it is not related to this. K is related to the extinction of the wave.

The use of the K value is optional. In most situations it is enough to just use the Nd value. Only in specific situations where the extinction effect is important, is it necessary to use the K parameter to get a more precise result.
The values of the extinction coefficients are obtained from measurements in laboratory, and are also included in the IOR files.

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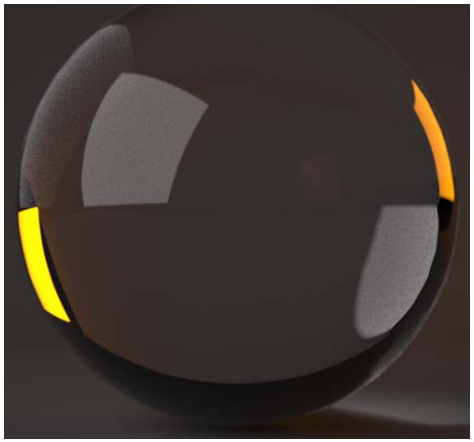
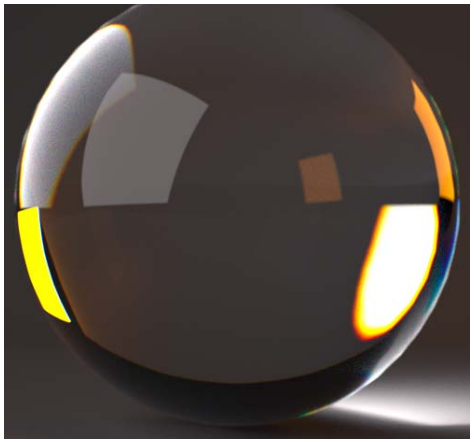
Abbe



F.01 Without Dispersion



F.02 With Dispersion active

Different wavelengths of light can be refracted at slightly different angles as they pass through a material, and this is what causes dispersion, the effect seen when a beam of light passes through a prism and is split up into the different wavelengths of light. The name Abbe comes from the German physicist Ernst Abbe, who defined the Abbe number. Abbe controls the amount of dispersion. The higher the Abbe number, the less dispersion will be visible in the render. An Abbe number higher than 60-70 will render as if dispersion was not activated.

Dispersion must be enabled in the Material Properties panel; otherwise the Abbe parameter in the BSDF will be grayed-out. Because dispersion generally takes longer to render, it is disabled by default.

R2

The "R2" name derives from the first time it was suggested, for the Mike Verta's R2D2 project. Generally, the falloff between the 0° color and the 90° is controlled by the Nd and roughness parameters. A high Nd number means more of the 90° color will be visible when using a low roughness value, but as you increase the roughness, the 90° color will start to disappear until at roughness 99 (or lambert), the 90° color will not be visible at all, no matter the Nd setting of the material.
This is normal behavior, but there may be special cases where you would like to control the influence of roughness and still keep the 90° color visible at high roughness. Examples would be car paints that quickly change their color to another color based on viewing angle, or velvet which has a high roughness but a bright "sheen" of a different color, which would not be possible to create without the .r2 parameters.

The first parameter can be set between 0-90 and controls the falloff angle between the 0° and 90° colors. The second parameter can be set between 0-100 and controls how much influence the roughness should have. For instance, if you write 45 0, the 90° color will start appearing when the viewing angle increases more than 45°, and roughness will have no influence on the effect. If you set the second parameter to 100, you are specifying that roughness should have maximum influence on the 0° and 90° colors; it would be as if you had disabled the .r2 functionality.

- **Other R2 examples**
  If we set the r2 values to 15 0, the 90° color will quickly become visible, right after the viewing angle is 15° or more. Roughness will not have any influence. Setting the r2 values to 70 50 means the 90° color will become visible only at a large viewing angle, making it appear just at the edges of the object. The increased roughness would make this effect less visible, but it would still show up. Using 85 99 means the 90° color will be visible only at the very edges of the object, but with the second parameter set to 99, which controls the influence of the roughness, the effect would be virtually invisible.

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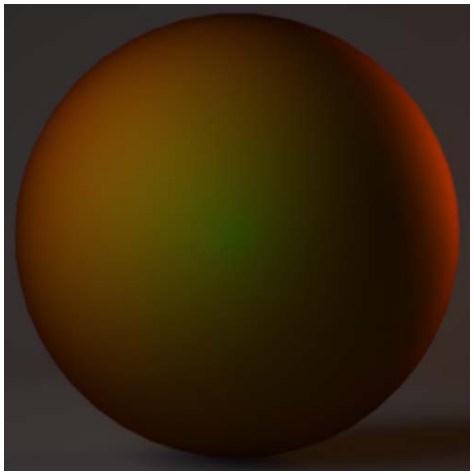
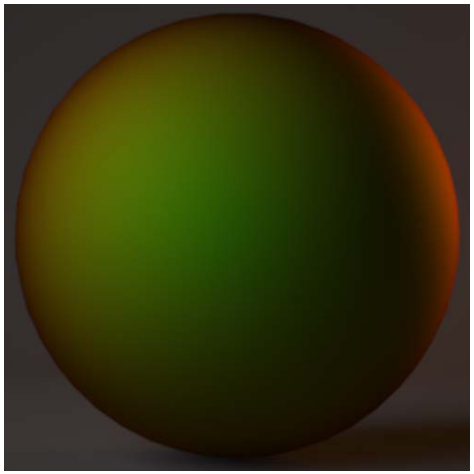


F.01 r2 values 15 0



F.02 r2 values 55 0

IOR Custom
This option allows you to set the value of the index of refraction (Nd) manually, as explained above.

IOR Measured Data
As an alternative to the Reflectance, Nd and Abbe values, you can use an .ior file which provides Maxwell Render with the exact index or refraction for each wavelength of a material. Complex IOR (also called Full IOR) data is collected from precise measurements in laboratories and describe the optical properties of a material to the highest degree of accuracy. These materials have the advantage of being extremely realistic, with some drawbacks:
The use of complex IOR data means Maxwell Render has a lot more math to do. Complex IOR computations require evaluation of more mathematical functions and they are dependent on viewing angle and on spectral wavelength. In addition, they involve the computation of full dispersion (which in itself introduces a performance hit; taking longer to resolve image noise). This method does not allow for many optimizations without sacrificing the intended physical accuracy.

Surface properties such as roughness, anisotropy and bump can still be changed when using IOR files. Naturally, a BSDF with an IOR file loaded can still be mixed with other "regular" BSDFs to create material variations.

- **When to use regular BSDF or IOR files**
  Suppose you work in jewelry and would like to render gold (and only gold in its pure form) and you do not mind waiting longer for a high resolution image, as long as the result is physically accurate in the most precise way possible; capturing the subtle effects of light and the unexpected shifts in color as it would if a real gold object was present. In this situation the use of a complex IOR material is recommended.

  On the other hand, suppose you are working on a two-minute animation of a gold robot for a TV production. In this case you need speed and flexibility. For instance, you might want the gold to look a bit redder and you might want it to reflect some blue light in some areas. In this case the extreme accuracy of an .IOR file is not needed. Instead, you can opt for a regular BSDF material and adjust the parameters until you get something that resembles gold in many respects. Your custom-made gold follows the physical laws of light for accuracy, while still being entirely customizable and production-friendly.

  As a general rule, .ior files that describe metals will not render much slower, but .ior files describing transparent materials involve the calculation of dispersion, increasing the render time. When using .ior files, dispersion cannot be turned off; it is "built-in" in the .ior file data.

10.04.02 Surface Properties

Roughness
Roughness allows you to add tiny imperfections and miniscule details on a surface to make it reflect light in a more diffuse way. The roughness of a surface can range from 0 (perfectly smooth surface) to 100 (pure diffuse). A roughness value of 100 corresponds to a "lambertian" or perfectly diffuse model. It is important to remember that if you want to have very smooth, mirror-like surfaces or clear glass, the roughness should be set to a low value (i.e. 0 to 10).

You can also set a black and white texture to control the roughness. Brighter values in the texture create a higher roughness (a more diffuse surface). When using a texture, the roughness number just applies to the maximum roughness needed. For example, if you

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use a black and white checker map as a roughness texture, and you set the roughness to 30, then the white parts of the texture will result in 30 roughness while the black parts will represent 0 roughness. If you now change the roughness to 70, the white parts of the texture will result in 70 roughness and the black areas will still represent 0 roughness.

It is important to understand how roughness controls the falloff between the 0° and 90° colors, i.e. which of these colors will be most visible. When roughness is low and ND is set to a higher value (Nd 5 or higher), the 90° color will be more visible. As the roughness increases, the 90° color will gradually lose its influence and only the 0° color will be visible. This will happen even with higher Nd values.

Anisotropy
This parameter controls how directional the surface reflections should be. Anisotropic reflections occur on a surface with micro grooves or details that run in one dominant direction. Like an old music LP with grooves that run in an organized circular pattern. These types of surfaces reflect light back in a specular way in the direction of the grooves, and in a more diffuse way in the direction perpendicular to the grooves. Many common materials that have been polished show anisotropic reflections instead of the usual isotropic reflections (that blur equally in all directions when increasing roughness).

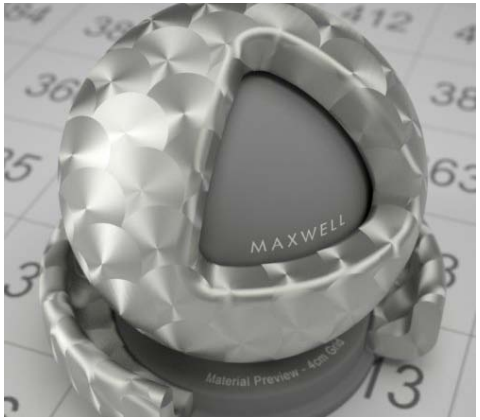
You can specify the anisotropy strength (0 for isotropic surfaces – 100 for full anisotropy). You can also set a grayscale texture to control the anisotropy strength. Brighter values in the texture specify higher anisotropy. When using a texture, the numeric control has no influence.

Angle
Specify the anisotropy angle; the main direction of the reflected light. You can also set a grayscale texture to control the anisotropy angle. Brighter values in the texture specify a larger angle. When using a texture, the numeric control has no influence.

An interesting way to use an angle map is to create the type of anisotropic reflections seen on surfaces that have grooves running in a circular pattern. The map should have a circular gradient that gradually increases in brightness.

F.01 Circular angle map

When applied to the top of a cylinder for example, you will get the typical anisotropic reflections of a surface that has been polished with a spinning polisher:



F.02 Image of a render with the circular angle map applied.

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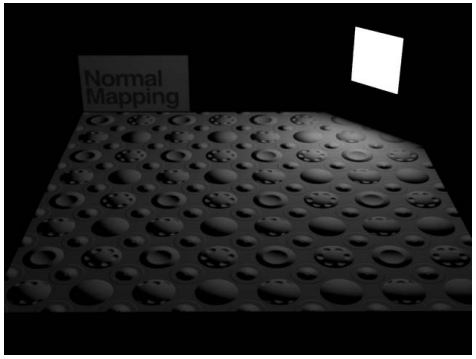
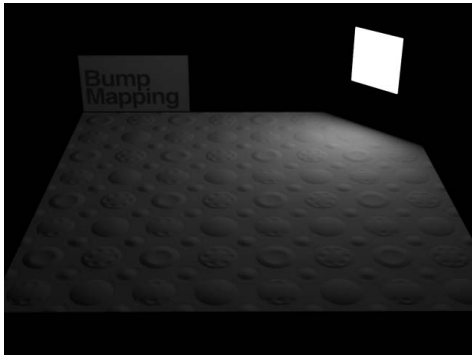
Bump and Normal Mapping
This parameter, much like the Roughness parameter, allows you to simulate grooves and imperfections on a surface, but at a much larger scale. For example, you can use a bump/ normal map to simulate wood grain. Keep in mind that Bump/ Normal mapping only simulates these grooves on the surface; it does not actually create the geometry in any way, like Displacement does.

Specify a Bump texture and the Bump strength. Brighter values in the texture will create bumps on the surface and darker values will create indents. You can use a color map as a bump map but only the grayscale information of the map will be used. Bump mapping can be a sensitive parameter and standard values should be around 1 – 25. A bump map with more contrast will produce a stronger effect, so the required bump strength depends on the particular map and the look you are after.

There is an additional option to specify a Normal map as a Bump texture. While a grayscale bump map can simulate only the up/ down direction of the grooves, a normal map has the additional advantage of specifying an angle, or the direction of the grooves. It is recommended to use a Normal map if you want to give the impression of very strong bumps/ grooves on a surface, or even to create a brick wall. A bump map is usually enough for smaller bumps, but if you are trying to simulate bumps that are too large just raising the bump strength of a bump map, that may not be enough.



F.01 Normal mapping

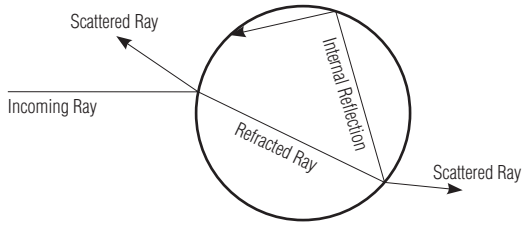


F.02 Bump mapping

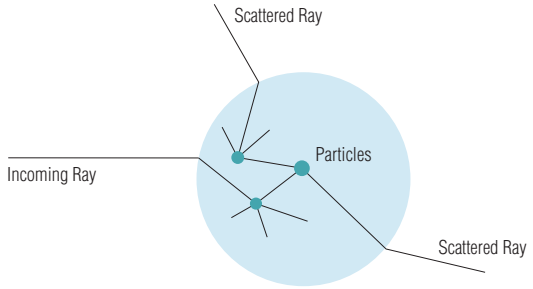
A normal map is a RGB texture, not grayscale. Each channel specifies an angle and the strength for the bump. Most modeling applications have an option to create a normal map from a detailed model, and there are also applications that allow you to convert a grayscale bump map into a normal map. When loading a normal map in the texture picker, the options Flip X, Flip Y, and Wide specify how the normal map was created. The most common standard is 'Flip Y', so this is selected by default. Consult the application you use to create normal maps to find out which of these options it uses to generate the maps.

10.04.03 SubSurface Properties

Subsurface Scattering (SSS) simulates the effect of light entering a translucent object and scattering inside it. Some of this light is absorbed and some is scattered back to the surface. SSS is a crucial component that allows you to accurately simulate many kinds of materials including plastics, marble, milk, skin etc.



F.01 Surface Scattering



F.02 Sub-Surface Scattering

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Maxwell Render has a highly sophisticated set of parameters designed to simulate both surface and subsurface scattering. You will find Subsurface Properties for each BSDF as a collection of parameters under a collapsible rollout. These parameters are:

F.03 SubSurface Properties panel

- **Scattering:** Scattering color is the reflectance of inner particles causing subsurface scattering. This means that the incoming light will be reflected/ scattered in this color.
- **Coef:** This coefficient defines the amount of particles inside the medium. Coef=0 (default) means there will be no subsurface scattering. In other words, the rays will pass through without hitting a particle. The higher the coefficient value, the more opaque/ less translucent the medium is. For example, lemonade is more translucent while marble is more opaque.
- **Asymmetry:** Asymmetry defines the isotropy of scattering. Asym=0 (default) means that light rays will be scattered equally in all directions. A negative value will let the light rays go through while a positive value will send the rays backwards. Besides the volumetric subsurface scattering just explained here, Maxwell Render also has a Single Sided mode which helps you simulate thin translucent materials like paper, leaves, and lampshades. The remaining parameters under this rollout only control Single Sided scattering.
- **Single Sided:** When this checkbox is ticked, Maxwell Render will disregard the volume of your object and consider it a hollow polygon surface with a virtual thickness. The aforementioned SSS parameters are also valid in this new mode. The value sets the virtual thickness of your surface in mm. You can also use a thickness map for more complicated effects.
- **Min/max:** These values define the minimum and maximum virtual thickness and are only available when a thickness map is used. The thickness map will be treated as a grayscale map using this given range. When this checkbox is ticked, Maxwell Render will disregard the volume of your object.

While the parameters under Subsurface Properties define the characteristics inside the medium, they are not enough to give the material its final look. We also have to specify the properties of the light ray that enters the material. Here, transmittance, attenuation, Nd and roughness play key roles.

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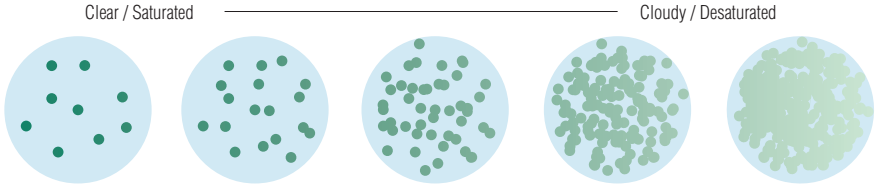
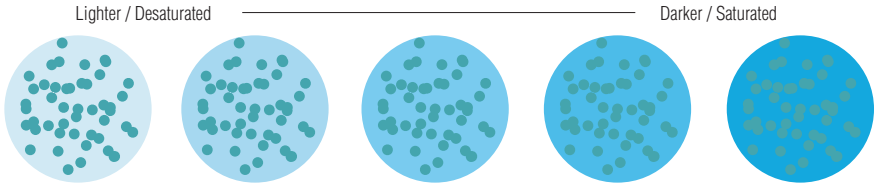
F.04 SubSurface Properties panel

- **Transmittance:** When a ray hits the surface, you need to allow it to enter the medium so it can create subsurface scattering. Set a transmittance color, which defines the color of the rays allowed to enter the medium. If the incoming light is white, the color of the rays beneath the surface will be equal to the transmittance color.
- **Attenuation:** No transmittance color will create proper subsurface scattering without a sufficient amount of attenuation. Attenuation defines the decay of light travelling inside an object. The lower the value, the less transmissive and translucent the object will be. It is important to understand that you can control the amount of light allowed to enter an object using attenuation (together with transmittance color) and the amount of cloudiness/ translucency using scattering color and the coefficient. See the images below.

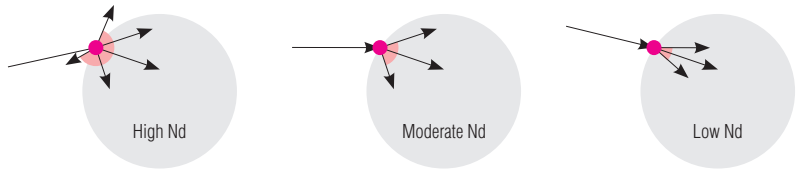


F.05 Effect of increasing Scattering Coef while maintaining Attenuation



F.06 Effect of decreasing Attenuation while maintaining the Scattering Coef

- **Nd:** Nd is the index of refraction /reflection. It is responsible for the Fresnel effect on the surface of a material, and also controls the bending of rays when they pass through a surface. It is essential that you use values between 1.0 and 2.5 to avoid unrealistic results. Space or air begins at 1.01 (for vapor, smoke, etc.) and dielectrics do not go higher than 2.5. The recommended range for common translucent materials is between 1.2 and 1.7.



- **Roughness:** Roughness defines the analytical perturbation on micro surfaces. Just like in any other material, it primarily controls the diffusion of specularity, and it is also responsible for the diffusion of rays on the surface before they go through the medium.

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So even with zero reflectance, roughness has an effect on the diffusion of rays. The rest of the parameters including abbe, r2, anisotropy, angle, and bump are fully compatible with subsurface scattering, allowing you to simulate the corresponding effects at the same time.

How to make a translucent material

Step 1 Step 2

1. **Step 1.** It is always a good idea to start by turning off reflectance, setting the reflectance to black and roughness to 0 to avoid creating reflections or specular effects on the surface. This will give you full control over SSS without introducing other effects. Now, set the transmittance, attenuation and Nd as if you were creating a typical glass material, but avoid setting a high attenuation. This will give you a dark-colored glass material as seen in Figure 1.

2. **Step 2.** Put particles inside the medium so that subsurface scattering occurs. Leave the scattering color set to grey or set another color, and increase the coefficient to 150. This will give you a material similar to the one in Figure 3: you have already created a simple translucent material. The incoming white rays are filtered when they hit the surface with the help of Step 1 and the green rays travelling through the object are being scattered with the given particle reflectance color and particle quantity. Figure 2 was rendered using a de-saturated transmittance color with the same settings to show the subtle subsurface scattering effect.

F.01 Transmittance F.02 SSS (isolated) F.03 Transmittance + SSS

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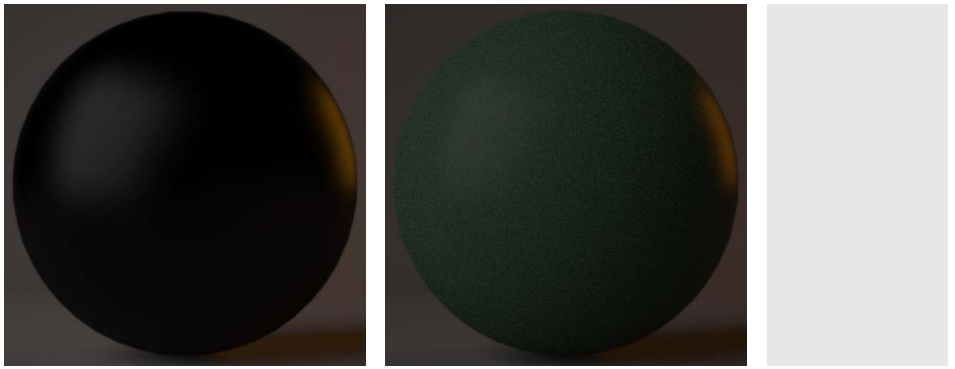
Step 3 Step 4

3. Step 3. Now that we have set the main parameters, we can adjust the speculars on the surface. Temporarily disable transmittance (set the color to black) and scattering (set coef to 0). This will help you to better visualize/ adjust the speculars. Now, set reflectance and roughness as usual and render to make sure it is looking like the material in Figure 4. As you can see, we can control the reflectivity of the surface without touching SSS. Keep in mind that a high reflectance may block the incoming rays more and may reduce the translucency.

4. Step 4. Go back to the transmittance color and the scattering coefficient settings from Step 2. The render will look like Figure 5. Notice that the speculars you set in Step 3 (Figure 4) are added to Figure 3, creating a complete material with its surface and subsurface. You do not always have to follow these same steps. With some practice, you will be able to set speculars and subsurface settings at once without going back and forth all the time.

F.03 Transmittance + SSS F.04 Speculars (isolated) F.05 Transmittance + SSS + Speculars



Step 3 Material Step 4 Material

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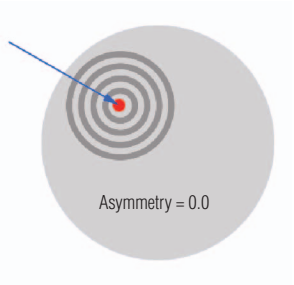
Additionally, you can add a Coating to the BSDF and the material will turn to a shiny Jade as seen in Figure 7. To avoid color interference in the coating, set it to 5000 nm or higher for a thick result. You can obtain a similar effect without using a coating, simply setting roughness to 0 in the BSDF.

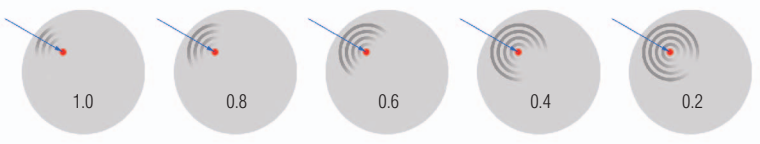
F.05 Transmittance + SSS + Speculars F.06 Thick Coating F.07 Shiny Jade

One of the most important parameters in subsurface is Asymmetry. By default the value is set to 0. This means that when a ray hits a particle, it is scattered randomly in all directions. It is useful for wax materials and common low-translucent plastics. Positive or negative values change the direction of scattering, as illustrated below. Positive values scatter the rays back, resulting in a more solid look, while negative values scatter the rays forward, resulting in a more translucent look.

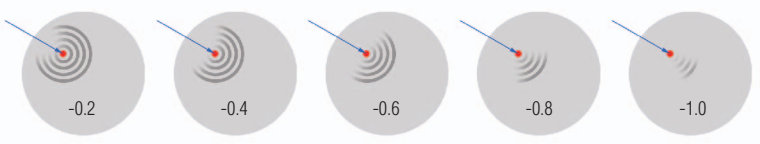


Asymmetry = 0.0

The example below shows the dramatic changes that result from +0.5 and -0.5 Asymmetry settings.



Response of particle to light under positive Asymmetry



Response of particle to light under negative Asymmetry

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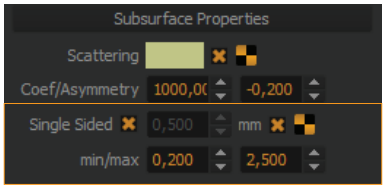
F.08 Asym + 0.5 (scattering) F.09 Asym + 0.5 (final look) F.10 Asym -0.5 (scattering) F.11 Asym -0.5 (final look)

Creating a single-sided translucent material



The "Single Sided" option is one of the most powerful features of the Maxwell Render subsurface system. It allows you to simulate thin translucent materials without having to model their thickness. When this option is checked, the surface shading will use the given virtual thickness and ignore the volume scattering.
It used to be a bit of a challenge to simulate leaves, paper, lampshades and so on. It was necessary to model the actual thickness of such objects to render them properly. You no longer need to model the thickness of these types of thin materials because the Single Sided option simulates a virtual thickness. You can also use a thickness map to simulating more complex materials. The image on the left shows a typical leaves render without SSS. The leaves are highly translucent and SSS is needed to simulate them properly. Without SSS, they cast dark shadows and look like painted cards blocking the light, removing all realism. On the right, you see a leaves image that was rendered using single sided SSS, which looks much more realistic.

F.12 Leaves without SSS F.13 Leaves with Single sided SSS

Before starting to create the leaves, it is assumed you already know how to create a translucent material (see above). Single sided SSS works in exactly the same way; the only difference is that virtual thickness is used instead of modeled thickness. In this example maps were used in nearly every slot to properly simulate the textures on the leaves. This might look complicated at first sight, but the idea is easy to understand with a bit of practice.

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As in the previous example, start without setting the reflectance and roughness. This will help you see the balance between transmittance and scattering. Your transmittance map should probably be the color of the leaves' texture. A leaf is not thick so make sure you do not set attenuation too high. 250 mm (1/4 m) is a good value to begin with. Turn on Single Sided and initially set a reasonable thickness like 0.5 mm (1/2 mm). You can leave scattering color to grey/ light green and set the coefficient to 1000. This is sufficient to obtain a simple translucent green leaf material. Now, filter, using the leaf texture, and scatter a uniform color using the given virtual thickness. This is not enough yet to actually create a real leaf so let's move on to the next step.

As can be seen on the right, the same single texture is normally enough to map all the required slots. It is easy to create suitable versions of the same map by altering the image properties under Texture Controls.

Transmittance and Scattering maps are responsible for the final color of the material, while reflectance maps, roughness maps and bump maps are responsible for the speculars on the leaves' surface. If you do not change the settings of the speculars – as described in the previous example – the result will be similar to Figure 14. Without reflectance and roughness applied, the result is similar to Figure 13. With all parameters set, your result will be similar to Figure 15, which is what we are looking for.

F.13 The final look

F.14 No speculars

F.15 Speculars only

Thickness is a new concept in this example. Because your geometry has no modeled thickness, this parameter tells Maxwell Render the thickness it should assume for the given surface. A real leaf has no uniform thickness and is thicker in veins and thinner in other parts, so we had to map the thickness. The thickness map will show enough contrast with a range starting at 0.2 mm for the thinnest areas and ending in 2.5 mm for the thickest areas.

Even though it works the same, Asymmetry plays a more important role in Single Sided SSS because it has a quicker and more obvious effect. A negative value will make the leaves more translucent when they are backlit. So a tracing paper would have a high negative asymmetry, while a normal paper would not.

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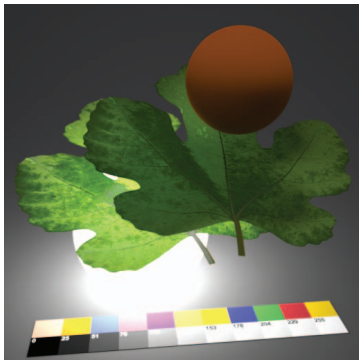
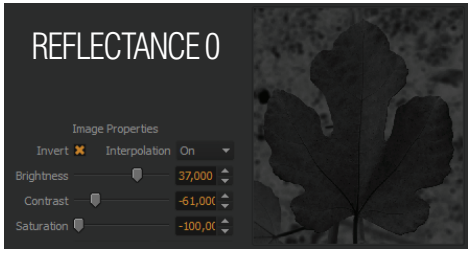
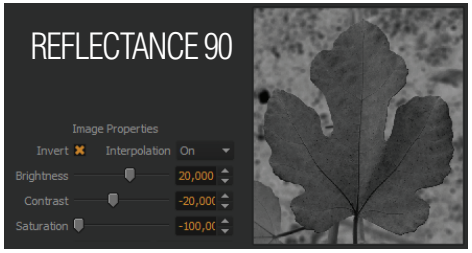
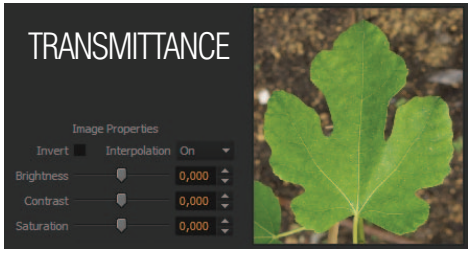
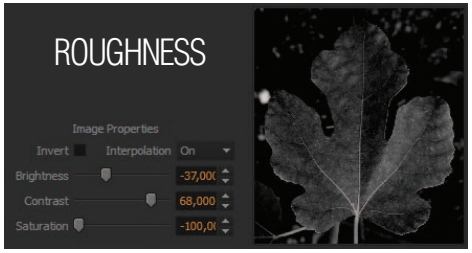


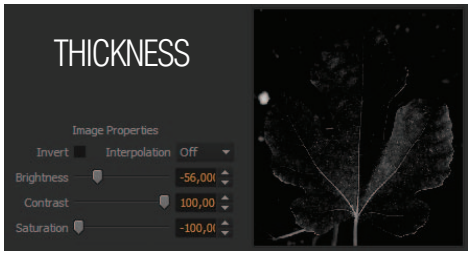
F.16 Backlit single SSS Leaves

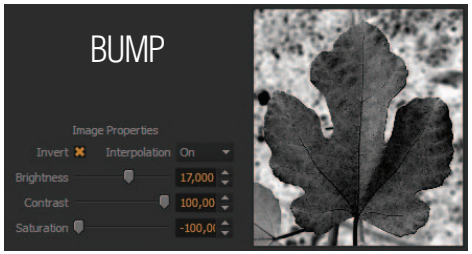












10.05 Coatings

Coatings are very thin layers that are placed on top of a BSDF. Because coatings are so thin, they produce an effect called thin film interference, which breaks up the light and can cause a rainbow-like pattern. Think for example of spilling a drop of oil on a surface of water. The very thin layer of oil will create interference patterns on the water. Coatings can also be used to create rough materials with a clear coating. For example, a glossy white plastic can be made combining a diffuse BSDF with a coating.

The main property of a coating is its thickness. The thickness is specified in nanometers (nm). Thickness can be specified by a numerical value or through a weight map. To avoid interference coloring, you should use higher thickness values such as 1 mm (1000000 nm).
Only one coating is allowed per BSDF. You can make a material using just a coating and no BSDF, for example to create a bubble material. To do this, add a coating, right-clicking

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on the BSDF component > Add Coating, and then simply hide the BSDF clicking in the visibility column in the layer list to disable it.

10.06 Displacement

Contrary to bump/ normal maps, the displacement feature simulates real geometry at render time as if it was actually modeled. This feature is very useful for adding fine detail to a mesh which would otherwise be difficult or impossible to actually model. Displacement uses a texture to define the geometric detail. Unlike many other displacement solutions which pre-tessellate the geometry, causing an increase in memory usage at render time, often of hundreds of megabytes for large detailed displacement, Maxwell's unique displacement method allows you to create virtually unlimited detail while using very little extra memory.
A displacement component can be added to the material (only one component per layer is allowed) by right-clicking in the Layers list area of the Material editor, or from the Edit menu of the Material Editor. Please note that, although you can have several displacement components in a material, only one of them will be selected for rendering. You can specify which one you would like to use by clicking on the Material Properties row in the Layers list.

To use displacement, you need an object with UVs, and a displacement texture. The texture is similar to a usual grayscale bump map, with different shades of gray to describe elevation levels. Lighter grays will raise the geometry and darker grays will create cavities.

Displacement Map
You must first load a displacement texture to access the displacement parameters. Maxwell Render can use 8, 16 or 32-bit grayscale displacement maps. It is recommended to use at least a 16-bit displacement image to create a smooth displacement, because 8-bit images may not contain enough gray levels (they only contain 256). You may see a stair-stepping effect if using 8-bit maps. 8-bit maps may be enough for displacements that do not require smooth transitions between gray levels, and additionally Maxwell Render's texture interpolation helps to render even 8-bit images smoothly.

Height
This parameter sets the maximum distance displaced. It tells the engine how much real geometric height you want to displace on your base mesh. This value needs to be greater or less than zero for displacement to appear. The white of your texture will be raised to the height value you set. Displacement height can be set in percentages or in absolute units:

- **Percentage (%):** Set the desired height as a percentage of the longest edge of the associated object's bounding box. For example, if you have a car of 300 x 150 x 110 cm and you set height as 1, this means the peak displacement will be 1% of 300 (the longest edge of the bounding box) which is 3 cm to be observed as real length in render output. Using relative height is useful when you wish to preserve the same displacement height when scaling the object.
- **Centimeters (cm):** Set the height in centimeters to always displace to this given value regardless of object dimensions.

Offset
This parameter allows you to specify which gray level in the texture should represent zero displacement. It is important that you set this parameter correctly, based on what type of displacement map you use. For example, some displacement maps may use 50% gray as zero displacement (darker shades than 50% in the texture will create cavities, lighter than 50% will raise the geometry). In this case, you should set the Offset parameter to 0.5 to get a proper displacement. If your displacement map uses black to represent zero displacement, set Offset to 0.

Gain
Gain defines surface accuracy, ability and response to detail, independent of texture resolution. It is a measure of the subdivision level of the mesh: the higher the Gain value, the more accurate the result, but also the more subdivision of the mesh during render time, meaning longer render times.
Gain and texture resolution are strongly related:

- When specifying a low Gain value and using a high resolution texture with lots of detail, the final image will not show more detail than what is allowed by the Gain value.
- When specifying a high gain value but using a low resolution texture, the image will reach the limit of the pixel detail of the texture and will not show a more detailed displacement. The displacement will reach the detail level of the texture. This is important to understand because you can optimize the displacement by starting with a high resolution texture and lower gain value, and keep raising the Gain value until the detail in the displacement is satisfactory.

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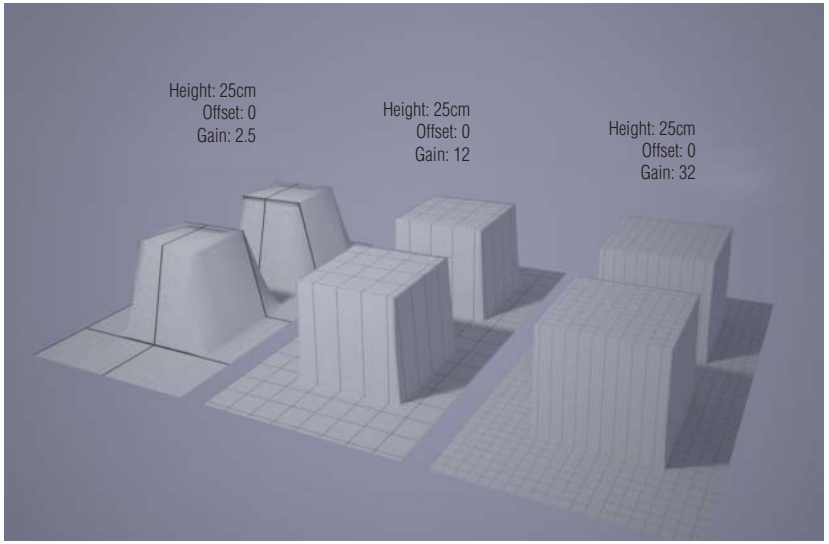
An example of how surface detail is affected by increasing gain for the same texture can be found below:



F.01 Displacement Test

This example shows that going beyond a gain of 32 (in this particular case) would not add more detail (while it would increase the render time). So it is important to avoid unnecessarily excessive Gain values.

Adaptive
The adaptive option locks the gain value to the given texture detail (at half pixel accuracy), which has the advantage of always creating the most detailed displacement that a given texture can provide. The user does not have to guess what the maximum gain value should be for that texture, or worry about exceeding it (which would increase render times but would not necessarily increase image detail, see example above). The adaptive mode should be used with care, because using a very large-resolution texture to represent some simple detail will result in unnecessarily long render times. The larger your texture, the longer the render times with Adaptive mode on because it will always render the maximum amount of detail for that particular texture. Adaptive mode should be used mainly to "test" your displacement textures first to see how much detail can be obtained from a given texture size. Then you can switch Adaptive off and manually raise the gain value until a level of detail close to Adaptive mode is reached, but without increasing the render time.

Smoothing
Similar to the object's smoothing angle setting, this parameter controls whether the displaced surface should render smoothly (continuous shading) or render faceted. It is generally suggested you leave this setting to "on", unless you aim to render very sharp, detailed displacements. Please note that the objects smoothing angle will still override the smoothing used for the object's base mesh faces, so if the object's smoothing angle is set to Flat (rendering the object faceted), and the smoothing parameter is set to "on" in the displacement parameters, a smooth displacement surface will be rendered over a faceted base mesh surface.

☑ *Tips to reduce the impact on render times:*

Render times can vary greatly. These three factors play an important role in render times:

- The base mesh vs. gain value (see below for details).
- The height of displacement (higher displacements will increase render times).
- How many displaced surfaces and objects the rendered image contains. For example, a common usage of displacement may be for a brick wall seen from far away, taking up 30-40% of the rendered image. In this case, low height and gain values can be used, and the impact on render times will be minimal. On the other hand, a close-up render of a displacement object taking up the whole image, using high gain values, will need more time to render clean.

Base Mesh vs. Gain
The more polygons you have in your base mesh, the less gain you will need to render the same amount of displacement detail. Displacements with less gain will always render faster. For example, if you are planning to render displacement over a plane, model your initial plane using more than 2 triangles. A typical 4 x 4 subdivision will speed it up remarkably.

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Appropriate base mesh geometry
Objects made of evenly distributed polygons are preferable because they provide better quality. You should avoid base geometry with disproportionate triangles that converge to the same point. In areas with many small, converging triangles you may get artifacts when using displacement.

Rendering sharp details
To render sharp details, consider turning off texture filtering. It will help you render sharper high-contrast areas in your texture. If you are using a moderate gain value, displacement will slightly smooth the rendered detail. In this case you should turn off Smoothing under the displacement options to render the details sharper. Keep in mind that turning off texture interpolation might reveal a stair-stepping effect if using 8-bit maps with smooth gradients.

Object Smoothing Angle
To avoid any possible artifacts/ gaps in the displacement on objects which contain polygons connected at sharp angles, make sure you set an object smoothing angle that exceeds the maximum polygon angle of the object (i.e. for a cube, it should be 90 or greater).

10.07 Special features

The "Matte" and "Shadow" options can be found in the Material Properties of the Material Editor.

10.07.01 Matte material

This option turns the material into a matte material which "cuts" through the entire image and reveals the background; physical sky if enabled; black if no environment lighting is used. This is useful for compositing purposes. For example, if you have columns in front of a character and the columns will be rendered in another pass, you can turn on matte material for the columns, and the character will be rendered with the columns "cut" from the character. The columns will still contribute to the lighting, even with Matte material turned on.

10.07.02 Shadow Channel

This option can be turned on for a material and will make all objects with that material applied behave as shadow catchers. If you turn on shadow channel in the Render Options panel, all materials that have this option turned on will only render shadows. All materials with this option turned off will render white. This allows you to render a shadow-only pass for compositing purposes. Keep in mind that the shadow pass progressively increases in quality, just like the main render. If you have both the main render channel and the shadow pass channel checked in render options, two separate images will be rendered, one being the main render, the other the shadow pass.

The following image demonstrates the procedure to export different channels from Maxwell and the final image after compositing:

1. The background image
2. The ground render
3. The ground alpha
4. The car and ground alpha
5. Objects ID channel
6. Material ID channel
7. Ground shadows
8. Car shadows
9. Roughness channel
10. Fresnel channel
11. Diffuse passs
12. Reflections Pass
13. Z-buffer channel
14. The final composition

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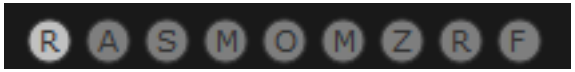
Remember that during the render, you can display the specific render channels that you've requested by hovering over the channel buttons in the render view.

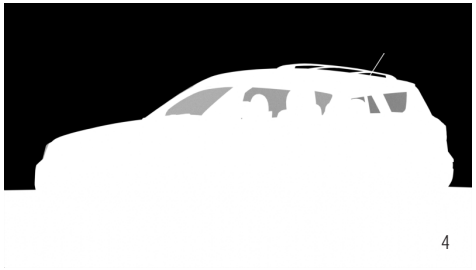


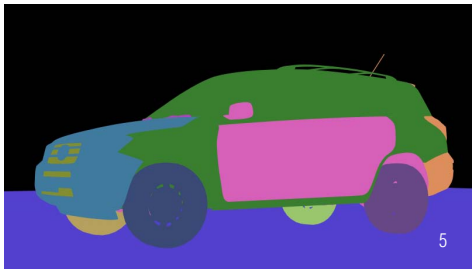
The icons represent:
R: Render channel
A: Alpha channel
S: Shadow channel
M: Material Id channel
O: Object Id channel
M: Motion vector channel
Z: Depth channel
R: Roughness channel
F: Fresnel channel

1

2

3


4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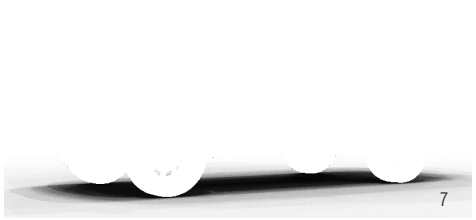
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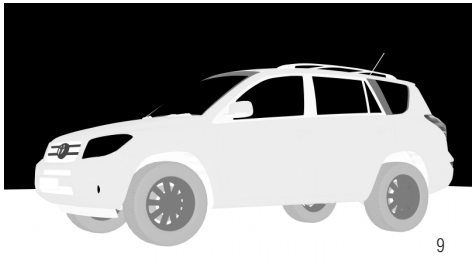
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10

11

12

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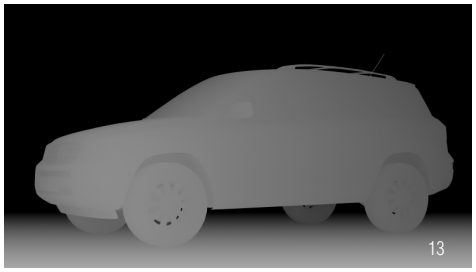
13

14

10.08 Useful tools for working with materials

10.08.01 The Material Browser

The Material Browser allows you to browse the Maxwell materials available on your system. It works similar to Windows Explorer, with a folder tree-view on the left side and the contents of the folder displayed on the right side.
The Material Browser is available from your 3D application using the corresponding plug-in, or from Studio as an independent panel. The Material Browser shows a small preview of every MXM file found in the material database.

10.08.02 The Wizards

Maxwell Render comes with an easy step-by-step guide to create various types of common materials such as shiny wooden floor, plastics, clipmapped materials for leafs, and subsurface scattering materials. The Wizards will ask you for textures, bumps, reflectance maps and material values such as roughness and color.

You can use the Common Wizard to create five types of basic materials: Diffuse, Emitter, Metal, Dielectric, and Plastic. The SSS Converter serves as both a Wizard and a converter of measured SSS data into values used in the SSS parameters of the Material Editor. You can simply choose a material from the Presets dropdown list and click OK, or you can tick the Advanced Settings check box which allows you to alter the pre-set or create an entirely new SSS material if you have access to measured SSS data.

10.08.03 The MXM Gallery and Maxwell Resources

The Maxwell Render material gallery, called the MXM Gallery, is an online library with over 3.600 free Maxwell materials available for download. It is an online community where Maxwell Render users share materials for direct use in scenes and projects.
The MXM Gallery is part of the Maxwell Resources website at http://resources.maxwellrender.com where you can also find free and downloadable Maxwell skies, illumination pre-sets and HDRIs.

10.08.04 Direct connection between Maxwell Render and the MXM Gallery

F.01 MXM Gallery button

The Maxwell Render 2 Material Browser has a direct connection with the MXM Gallery. Open the Web tab (icon above) to search for materials in the online MXM Gallery. Type in a word to do a search, select the material you need, and drag it over the Material Editor, in the Materials List Panel or over the desired object to import the material into your scene.

The material will be downloaded to your computer, unzipped and placed either in the current project folder (the folder where the MXS file is located), or in the folder you have specified in Preferences> Materials> MXM gallery. In the search results, you can click on a column to sort the materials by that column, and you can double-click on the material thumbnail to display a larger version of it. Please make sure you have written your login/password information in Preferences> Materials> MXM gallery to be able to log in and download materials.

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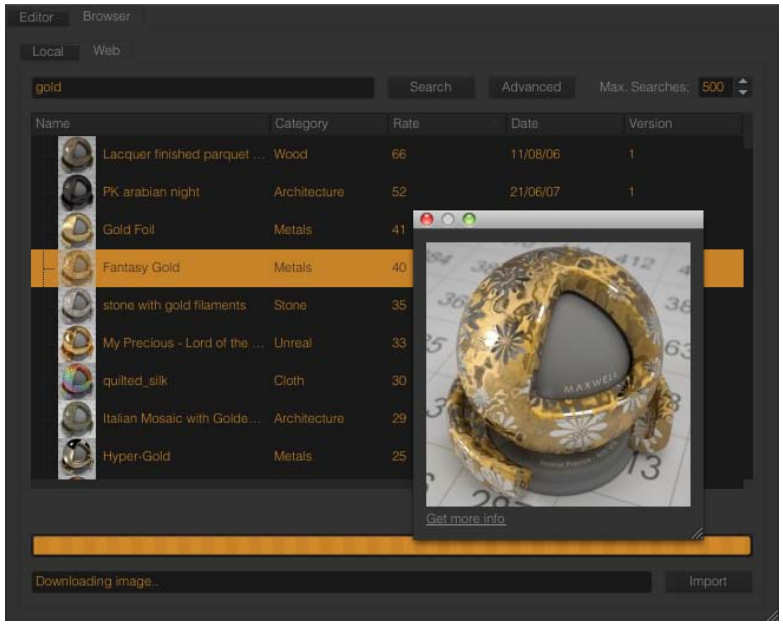
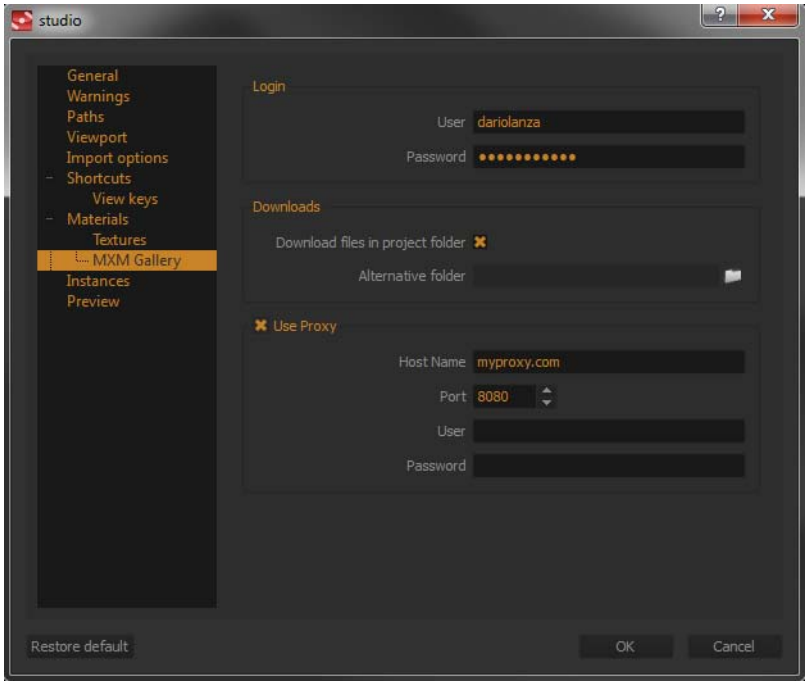


Note: If you are connecting to the internet through a Proxy, you must set the proxy Host Name, Port, Username and Password through Preferences>MXM Gallery.



10.08.05 Material examples

In Appendix I you will find practical examples and tips to help you better understand the material parameters and create your own MXMs. We strongly encourage you to take a look and experiment with the material system.

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11 THE NETWORK SYSTEM

11.01 The Network System

The network rendering system was created to distribute the rendering process among various CPUs to reduce render times.
The Maxwell Render network system offers a solid and stable performance and is easy to set up.

The network system allows you to:

1. Launch a cooperative render with several machines working together to render the same image. The contributions of the machines are merged in a single image.
2. Launch a non-cooperative render queue, distributing the scenes among the available CPUs, but every CPU renders an independent image. Each machine works on its own frames.
3. Launch an animation, distributing the frames among the CPUs in the farm to get the whole frame range.

The network system (mxnetwork.exe or mxnetwork.app in Mac or mxnetwork in Linux) is composed of three components:

1. The Manager: distributes the jobs between the available render nodes. It also merges the images in a cooperative render.
2. The Render Nodes: the computers that actually render the frames.
3. The Monitor: Interface that allows you to add jobs, assign jobs to nodes, stop a network render, display info about the current job and show a merged preview of a network render in progress.

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You can choose to start the Manager, a Render Node or the Monitor on a computer by clicking on the appropriate shortcut (mx_manager, mx_node, mx_monitor). Please note that a computer that runs the Manager and/ or the Monitor can also be used as a Render Node at the same time. The Maxwell network can render across a mixed network of computers running Windows, Mac, and Linux.

It is also possible to start the Manager, Render Node or Monitor through the command line, using:

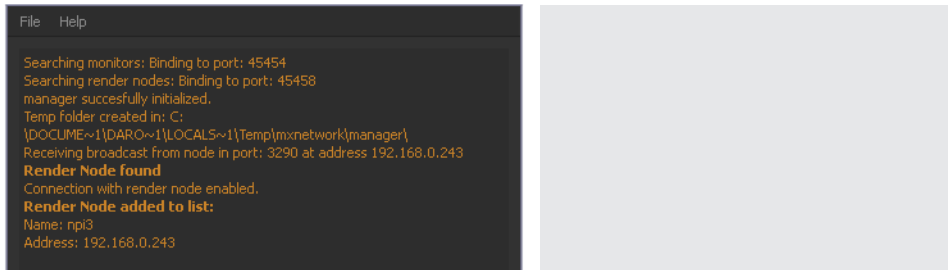
- mxnetwork –manager
- mxnetwork –node
- mxnetwork –monitor
- Type in mxnetwork –help for more information about advanced command line flags to connect a Render Node or a Monitor to a specific Manager if there is more than one in the same network

Only one instance of each type (manager/ monitor/ node) can run in the same machine at the same time. It is not possible to run two Monitors, two Managers or two Render Nodes in the same machine simultaneously.

11.02 The Manager

The Manager of the render farm is responsible for managing the render queue and distributing jobs in the network. The Manager interface will display information about the status of the network, any new events such as a render node connecting, and render- and merging information. It is constantly communicating with the Render Nodes and Monitor(s) in the network.

To start the Manager, click on the mx_manager shortcut.

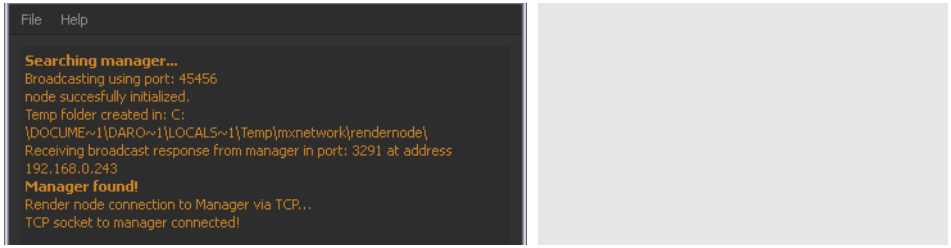

File Help
Searching monitors: Binding to port: 45454
Searching render nodes: Binding to port: 45458
manager succesfully initialized.
Temp folder created in: C:
\DOCUME~1\DARO~1\LOCALS~1\Temp\mxnetwork\manager\
Receiving broadcast from node in port: 3290 at address 192.168.0.243
Render Node found
Connection with render node enabled.
Render Node added to list:
Name: npi3
Address: 192.168.0.243

F.01 The Manager

11.03 The Render Nodes

The Render Nodes are the computers that actually render the frames. To add a computer as a Render Node to the network, double-click on the mx_node shortcut. The node interface will display information about the status of the render.

You can only run Maxwell Render in network if you have more than one license, for example 2 Standard licenses or 1 Standard license and 1 RenderNode. You can then use the Standard license to run your main machine, where you set up your scenes and the Manager to distribute jobs. The RenderNode license can be used to run an additional machine for rendering only. Always make sure that all the machines in your network have access to the Maxwell installation folder where your license file is located.



F.01 The Render Node

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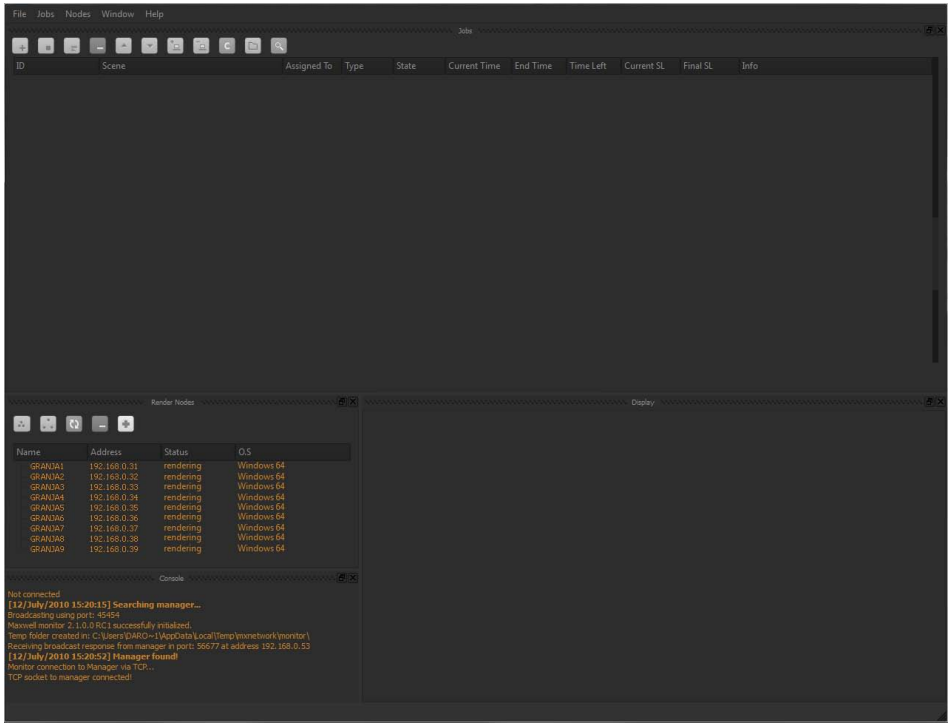
11.04 The Monitor

To start the Monitor on any of the computers connected to the network, click on the mx_monitor shortcut.

The Monitor interface has several elements:


File Jobs Nodes Window Help
Jobs
ID Scene Assigned To Type State Current Time End Time Time Left Current SL Final SL Info
Render Nodes
Display
Name Address Status O.S
GRANJA1 192.168.0.31 rendering Windows 64
GRANJA2 192.168.0.32 rendering Windows 64
GRANJA3 192.168.0.33 rendering Windows 64
GRANJA4 192.168.0.34 rendering Windows 64
GRANJA5 192.168.0.35 rendering Windows 64
GRANJA6 192.168.0.36 rendering Windows 64
GRANJA7 192.168.0.37 rendering Windows 64
GRANJA8 192.168.0.38 rendering Windows 64
GRANJA9 192.168.0.39 rendering Windows 64
Console
Not connected
[12/July/2010 15:20:15] Searching manager...
Broadcasting using port: 45454
Maxwell monitor 2.1.0.0 RC1 successfully initialized.
Temp folder created in: C:\Users\DARIO~1\AppData\Local\Temp\mxnetwork\monitor\
Receiving broadcast response from manager in port: 56677 at address 192.168.0.53
[12/July/2010 15:20:52] Manager found!
Monitor connection to Manager via TCP...
TCP socket to manager connected!

F.01 The Monitor

11.04.01 The Menu bar

File:

- **Preferences:** This is a Preferences panel. You can choose which TCP port the Monitor should use for the network rendering and you can also specify the maximum number of nodes that should be used for network rendering. The TCP port setting is useful for networks that block certain ports. You can force any node to work always in Low or Normal priority, or to share a desired number of threads. You can also start the Manager and Render Node hidden in tray if you prefer.

  ☑ *Important: It is strongly recommended that you do not change the Port Range value unless you are an expert network administrator. It is critical that all the machines in the Maxwell Render network are using the same port, otherwise the system will not work properly.*

- **Open temp folder:** Opens the temporary folder of the Maxwell Render network where all the temporary files of the render jobs are stored.
- **Purge temp files:** Use this option to delete all the temporary files on this computer. The temporary files are purged automatically when a render job has finished.
- **Remove finished jobs:** Clear all the completed network renders from the Jobs panel.
- **Clear console:** Clear the messages in the Console panel.

Jobs:
From here you can add, stop or remove selected jobs. You can edit a job to change the target Sampling Level or Time during the render.
You can increase or decrease the priority of a certain job, include a new extra node into a certain job, or release a node from a certain job.
You can also preview a selected job while rendering, remove all the finished jobs and open the output folder.

Nodes:
From here you can group/ungroup several nodes into one entity to easily assign different tasks to different groups. You can also reset a pending node, or kill a node when you need to free that computer for other tasks, and you can reset all the nodes if you need to.

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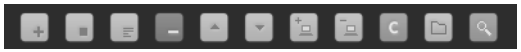
Window:
Choose which panels you want to hide/ display in the UI.

Help:
You can consult the network section of the Maxwell Manual, or visit our tutorial website via the direct link to THINK! where you can find lots of free (video) tutorials to help you understand the ins and outs of Maxwell Render.

11.04.02 The Jobs panel

View a list of jobs submitted to the render farm and complete information about them: ID of the working node, Scene, Type of Job, Priority, Status, Current Time, End Time, Current SL and Final SL. All the options can be also accessible through the right mouse button menu.



The icons allow you to:

- Add a new job to the job queue
- Stop the selected job
- Edit the target Sampling Level or Time of the selected job
- Stop a job and remove it from the job queue
- Increase or Decrease the priority of the selected job
- Add certain nodes to the selected job
- Release the selected nodes from a certain job
- Release finished jobs from the job list
- Open the output folder of a job
- Preview the selected job

11.04.03 The Nodes panel

View the Render Nodes available in the network.

The icons allow you to group/ungroup several nodes into one entity to easily assign different tasks to different groups.
You can also reset the selected nodes or Reset the entire network. This will stop its current work and purge all its pending tasks. This can be useful to restore a node after a problem without needing to restart the whole network.
You can also close the mxnetwork application in the selected nodes, to free those computers for other tasks

11.04.04 The Console panel

Displays information and messages about the rendering process. If there are any issues with a render job it will also be displayed in this panel.

11.04.05 The Display panel

One of the most powerful functions of the Maxwell Render network system is the Display function. While the Nodes are rendering, you can select any of them and press the Preview button to automatically display the image being rendered on that node.
The Preview button also supports instantaneous viewing of a cooperative job as merged during the render progress. To do this, select the job tree (instead of just one server) and click Preview. This way you can preview the final result of the Nodes that are working together on that frame (an instantaneous merging process is executed to perform this interactive Preview).
You can even order a preview of an animation job, by selecting the animation job and hitting the "Preview" button.
This will create a display for all the rendered frames of the animation, and will allow you to play the animation using the Shift + right arrow key (play forward) or Shift + left arrow key (play backward).

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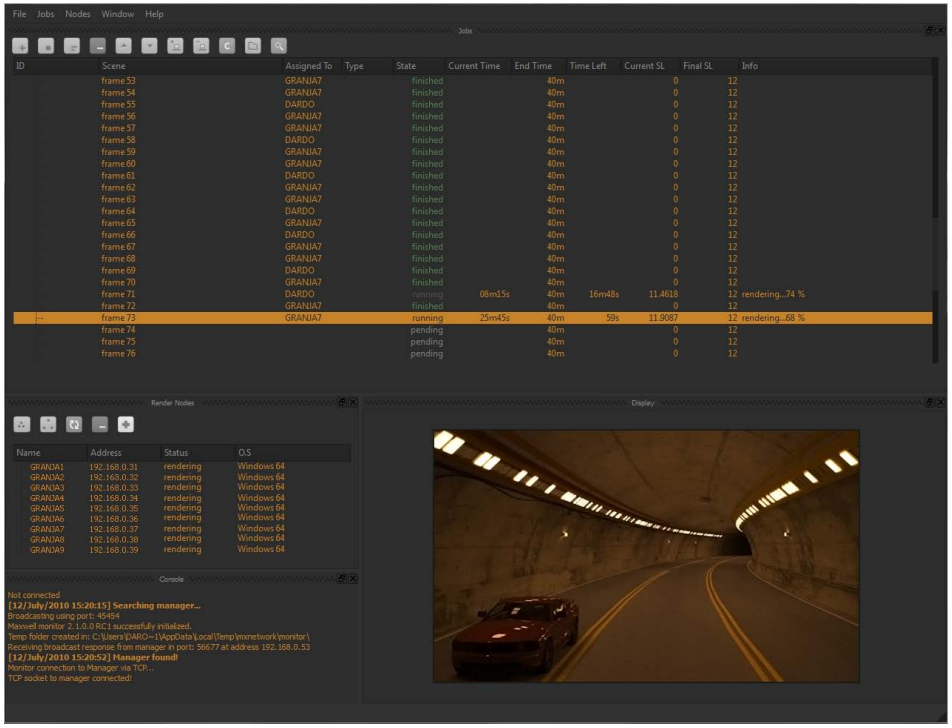
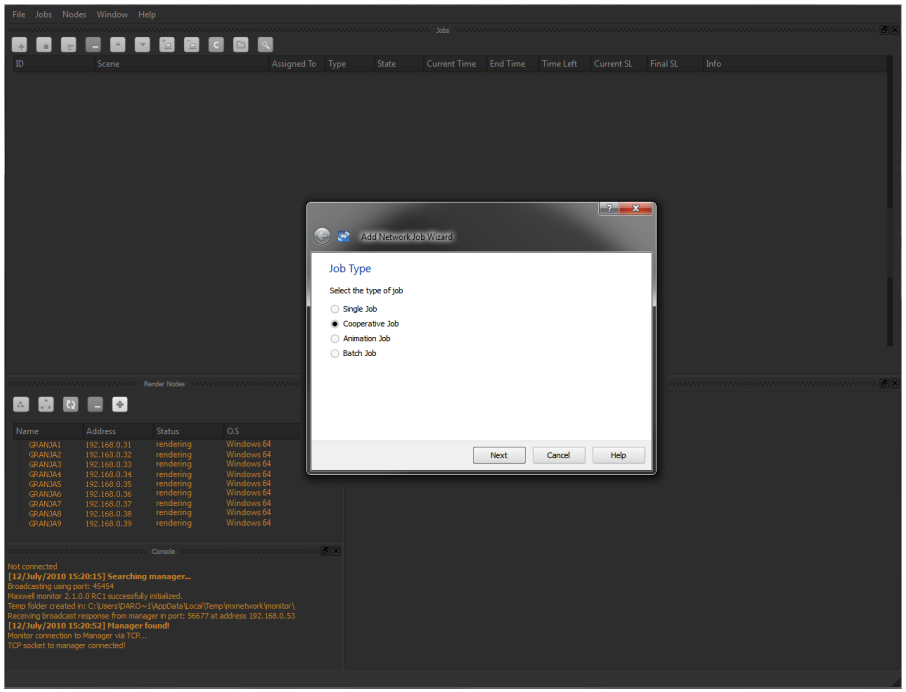

File Jobs Nodes Window Help
Jobs
ID Scene Assigned To Type State Current Time End Time Time Left Current SL Final SL Info
Render Nodes
Name Address Status O.S
Display
Console
Not connected
[12/July/2010 15:20:15] Searching manager...
Broadcasting using port: 45454
Maxwell monitor 2.1.0.0 RC1 successfully initialized.
[12/July/2010 15:20:52] Manager found!
Monitor connection to Manager via TCP...
TCP socket to manager connected!

F.01 Displaying a render

11.05 Setting up a render

Setting up your own render farm can be done in a few simple steps:

1. Make sure all your computers are properly connected to the network, and check the read/ write permissions on each machine, for example by checking that the currently logged-in user can write a file in the folder you intend to specify as the output folder for network rendering. Make sure there are no firewall restrictions on the machines prior to initializing the Maxwell Render network.



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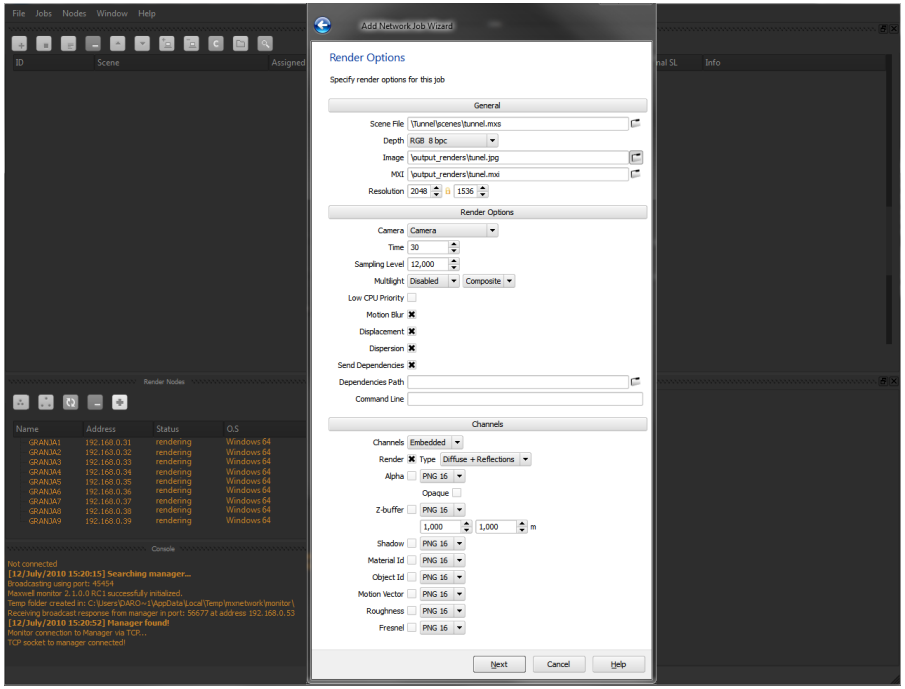
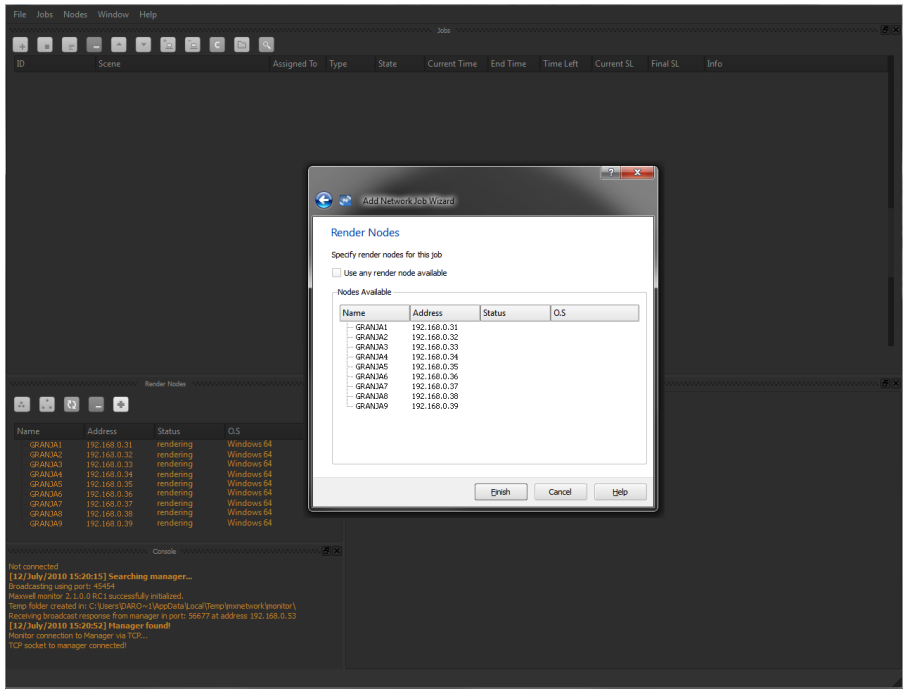
2. Launch the Manager.exe on the computer that is going to run as Manager, and launch RenderNode.exe in the computers that are going to work as nodes. Remember that you can also run a node on the computer that is running the Manager. It can manage the network rendering and also contribute to the rendering process.



3. Launch the Monitor.exe on the computer where you want to control (launch/ display/ stop) the rendering process. The Monitor will automatically connect to the network to search for the Manager and the available Nodes. They will be listed in the Nodes panel. The Monitor can run on the same computer that is running the Manager. Check in the Monitor>Nodes panel that all your computer nodes are listed there. If some of them are not listed, check the firewall settings on that computer and make sure it is not being blocked.



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4. Use the Add button to submit a job. This will open the Add Job Wizard to help you through the process. Select one of the following options.

   - **Normal render:** to make a non-cooperative render queue with each node working on an independent frame.
   - **Cooperative render:** several computers work on the same image, which will be merged at the end of the process.
   - **Render Animation:** select a scene and the frame range, and the frames will be distributed among the available nodes. Remember that you can also render single frames from the same sequence by using a semi-colon ";" when typing. For example: 1-10;12;20-23 This will render frames 1 through 10, frame 12, and finally frames 20 through 23. Any padding number is allowed.
   - **Batch render:** This option allows you to select multiple scenes to be rendered. All the scenes are rendered using their own settings and output paths. You can perform changes in the rendering settings (render time, SL, resolution, camera, etc), and this changes are applied to all the scenes added. An interesting feature is that in this mode you can choose the Batch Type, between Cooperative type (all render nodes work together in the same scene before starting with another) or Single type (each render node renders a scene separately).

5. Select the networked path of the scene to the output files. Set the frame range (for animations), and set the Render Options (Time, Sampling Level). You should also specify an MXI output, not just the image output. It is possible to select bit depth and file format independently for each render channel. They can be saved in the same folder. The "send dependencies" option will send all files the scene is dependant on (textures, IOR, HDR files) to the Render Nodes. This is very useful to avoid problems when too many computers are trying to read files from the same folder. You should leave this option checked unless you have a very fast file server. If you wish to restart a network render, the Maxwell network will check if the files are already on the Render Node and will not transfer them again.

   You can visualize the progress of the network render in the Jobs window in the Monitor. You can stop the process, remove any job, add more jobs to the queue, and display the images that are being computed by the network.

6. Choose a networked path to locate the source files of the project (scenes, textures, materials, etc). It is highly recommended to use networked paths for your project files, especially for the output files.

   Although highly recommended, it is not necessary to also put the scene in a networked path; it is enough if the Monitor can access it through the open file dialog. In addition, if the "Send Dependencies" checkbox is on (default), the scene-dependent materials do not need to
   be in networked paths, as they are sent from the Monitor to the Rendernodes. This option is faster and has several advantages, but it requires that the Monitor that submitted the job remains on until all nodes start.
   However, if the "Send Dependencies" checkbox is off, the scene-dependent materials should be located in a networked path accessible from all the Render Nodes, that will pick them all as they need them. The output image paths should be network paths accessible from the Manager, which is the machine that is going to save the final output there.
   This option ("Send Dependencies" disabled) produces a slower file transfer, but it can be useful when you need to switch off the Monitor that submitted the job, or when you have a fast repository server for scenes and textures.

   You can visualize the progress of the network render in the Jobs window in the Monitor. You can stop the process, remove any job, add more jobs to the queue, and display the images that are being computed by the network.

7. Resuming a network job: Resuming jobs in the Network System is possible for Single, Cooperative and Animation jobs.

   When submitting a job, the system checks automatically if the MXI output exists, and if so it asks you to resume or start the job again.

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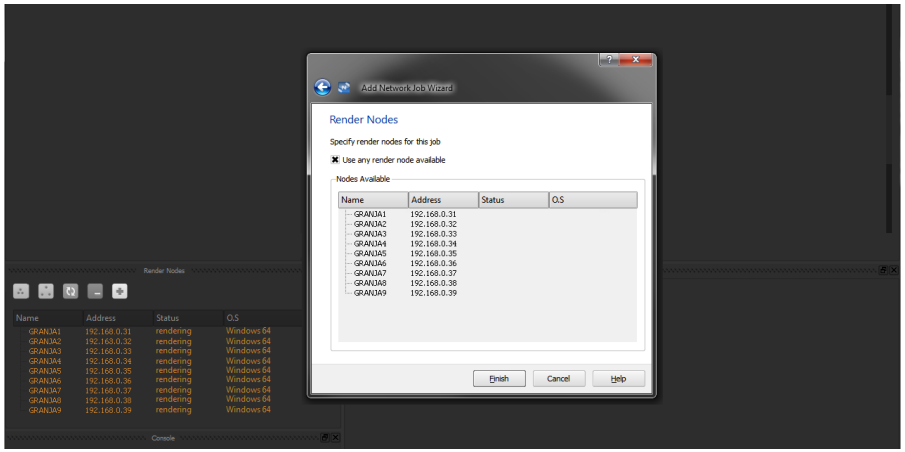

First make some simple tests in your network before attempting a real project or final rendering to ensure that all the Render Nodes can connect and the output is written properly.

11.06 The Merging process

Cooperative mode is a special mode that allows selected nodes to work on the same frame individually and to merge the images they have created at the end of the rendering process.

You can activate Cooperative mode by selecting it in the Wizard panel when a job is submitted.

While rendering, multiple nodes will render the same frame with a different starting "seed". When the job is finished, the Manager will collect these results and merge them into a single output file. It is possible to preview cooperative jobs while rendering by selecting the job tree and pressing the Preview button.

11.06.01 Merging Manually

If the network fails or crashes at some point and the merging of MXI files is not completed (you can check the Monitor nodes and manager for error messages), you can manually merge the cooperative MXI files created during the render process. All the Render Nodes save the current MXI file in their temp folder (accessible through Menu > Open temp folder). The Manager also stores all the MXI files from the nodes in its temp folder, creating a subfolder for each job so it is easier to find the set of MXI files you are looking for and merge them manually.

In order to make a cooperative render work, each MXI file must have a different starting "seed" so that each render has a slightly different noise pattern. This random seed value is given automatically by the -idcpu command; the user does not have to specify it himself.

11.07 Common Network situations and tips

If you are working in Windows and want to run more than ten Render Nodes simultaneously, all the folders need to be set up on a machine that is running Windows Server because any other version of Windows will only allow ten simultaneous connections at any given time. Make sure you always check the "send textures" option. If you are in Linux or Mac this problem does not exist.
When rendering animations, make sure that you have plenty of free hard drive space. Each MXI file can easily be 100+ MB in size, especially if Multilight is enabled, and will quickly fill up a small drive.

MXS saved with local texture paths
Unless you use the "Send Dependencies" option when adding a network render job, both the MXS file and textures used in the MXS should be placed in a shared folder that all nodes have access to. An easy way to accomplish this is using the "Pack & Go" feature in Maxwell Studio which will copy your MXS and all the textures used in it to a folder of your choice. Otherwise you may get a texture paths error.

Alternatively, you have two options to make sure all nodes find the textures:

- You can keep your textures in a shared folder and when building your scene, you load the textures from this folder starting from Network in the File Browser so that the texture paths are in UNC format.

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For example, your texture folder may be c:/mytextures, which is shared. Your computer name is "renderbox1" which is part of the Workgroup named "farm". Browse from My Network Places> Microsoft Windows Network> farm> renderbox1> my textures. The path for the texture will then be

```
\\renderbox1\mytextures\texture.jpg.
```

You can also type directly in the File name input of the File Browser: \\renderbox1 and your mytextures folder will appear in the list of shared folders. In this case it is not necessary to also move your textures to the same shared folder as the MXS.

- You can keep your textures in a shared folder and when adding the job through the Add Job Wizard, you can specify this shared folder in the "Textures" dialog.

Using a mapped network drive
In case you are connecting to a folder as a mapped network drive, make sure you have added this folder as a mapped drive to all the servers, using the same drive letter.

Firewalls
If you are having problems detecting the nodes in your network, disable your firewall.

11.07.01 Network tips for Mac OSX

For multi-platform compatibility reasons, all the network paths in Maxwell Render are in UNC format by default. Mac OSX cannot handle UNC paths natively and so some transformations are needed. These transformations cannot always be done automatically, so keep the following tips in mind to make network rendering much easier when using Mac OSX.

- Checking the "Send Dependencies" option will be faster and more reliable in most cases.
- In a multi-platform environment, it's preferable to use Mac OSX machines only as render nodes.
- When launching the render from a Mac OSX machine (and if the Manager is not in the same machine as the Monitor), the output path must be understandable and accessible from the Manager machine.
- If the Manager is a Mac OSX machine, selecting a local path will save the file in the same local path (if it exists) as the Manager. Using the "Retry" button of the local path warning dialog will convert this local path to a network path. This means the files will be saved in the referring path, but the selected local path must be located in you user folder (or in any of its subfolders) or in any secondary drive.
- If the Manager is a Windows machine, a network UNC path must be written by the user, or a Windows shared folder must be selected in the dialog.
- When "Send Dependencies" is not selected, the texture path has the same limitations as mentioned in previous point, but now for all the nodes in the network.

11.07.02 Network tips for Linux

Linux can have problems with UNC by default, so a workaround is needed.
To make Linux work with network paths for textures or other dependencies, it is possible to use this hack:

Let's suppose you want to access:

```
\\MyServer\Share1\texture.jpg.
```

The workaround consists of creating a folder in the root of the rendernode file system (hanging from /) named MyServer (case sensitive), and inside MyServer, a folder named Share1.

Now, you can mount the shared resource \\MyServer\Share1 in the folder /MyServer/Share1 (pay attention to the particular back and forward slashes) using this command as root:

```
mount -t cifs //ip-of-the-server-MyServer/Share1 /MyServer/Share1
-ousername=an-authorized-user,password=the-appropriate-password
```

If you have smbfs module loaded in your kernel, then you can do:

```
mount -t smbfs //Myserver/Share1 /Myserver/Share1
```

For example: if the IP of MyServer was 10.10.10.1, then:

```
mount -t cifs //10.10.10.1/Share1 /MyServer/Share1
```

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This is a tricky hack, and you've got to adjust the write and read permissions, and be root to be able to mount the shared folders, but it works and can sometimes be the easiest solution.

11.08 Using a 3rd party job manager with Maxwell Render

Maxwell can run as a command line application so it can be controlled from any external process though command line flags. It allows you to connect it to any job manager in an standard way.
The most typical scenario is rendering a single job or an animation. In that case the job manager just has to call maxwell using the following command line (be aware the paths could be different in each system):

```
> C:\program files\next limit\Maxwell 2\maxwell.exe  -scene:"D:\scenes\
test.mxs"  -mxi:"D:\output\test.mxi"  -o:"D:\output\test.tiff" -sl:15
-res:1024x768  -nogui   -nowait  -node
```

This command line instruction opens Maxwell Render and renders the scene "test.mxs" with the given sampling level and resolution and saves the output in the paths specified with the "-mxi" and the "-o" flags.

The flag "-nogui" forces Maxwell to run in console mode. The flag "-nowait" forces Maxwell to close after the render finishes. The flag "-node" forces Maxwell to use a node license instead a full license.

See Appendix III for a full list of command line flags, or type:

```
> maxwell.exe -help
```

to learn more about Maxwell Render command line flags.

If the paths contain spaces they should be placed inside quotes as shown in the example. To avoid typing the full path to the Maxwell executable in Windows every time, you can append it to the PATH environment variable. Typing "maxwell.exe" will work no matter where the current path is.

Maxwell Render can be killed from the job manager using any standard procedure to kill processes. When Maxwell Render receives a kill signal it stops the render, saves the output and closes.

It is also possible to run cooperative renders (more than one machine rendering the same scene) through the command line.

To do so just follow these steps:

1. Render as many images as you want, using a different seed in each one. The seed can be set with the flag "-cpuid:ID"

2. Merge the MXI output of all of them into one MXI file. To do so, use the mximerge tool included with the Maxwell Render package. For example, let's say you have rendered ten MXI files that are in the folder D:\myproject\output.

To merge them just type:

```
> C:\program files\next limit\Maxwell 2\mximerge.exe  -folder:"D:\
myproject\output\"  -target:"C:\merge_test.mxi" -image:"C:\merge_test.
png"
```

This command line instruction merges all the MXI files located in the folder " D:\myproject\output\" into one "merge_test.mxi" and it also extracts the image and saves it in "C:\merge_test.png"

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12 MAXWELL STUDIO

Maxwell Studio is a full, standalone application to render scenes and objects imported from other 3D applications.

Maxwell Studio provides the following functionality:

- Import object files.
- Set attributes of objects (position, rotation, scale, pivot, smoothing, normals, etc).
- Apply textures using UV projectors.
- Apply physical materials and lights.
- Visualize the 3D scene in graphical viewports.
- Create multiple cameras and adjust their position and parameters.
- Set sky options and see an interactive representation of the sky settings in the OpenGL viewport.
- Fully customizable layout with the ability to save layouts.
- Libraries of pre-set scenes, materials and layouts.
- Fast interactive preview, for interactively rendering your scene and displaying your changes in real time.

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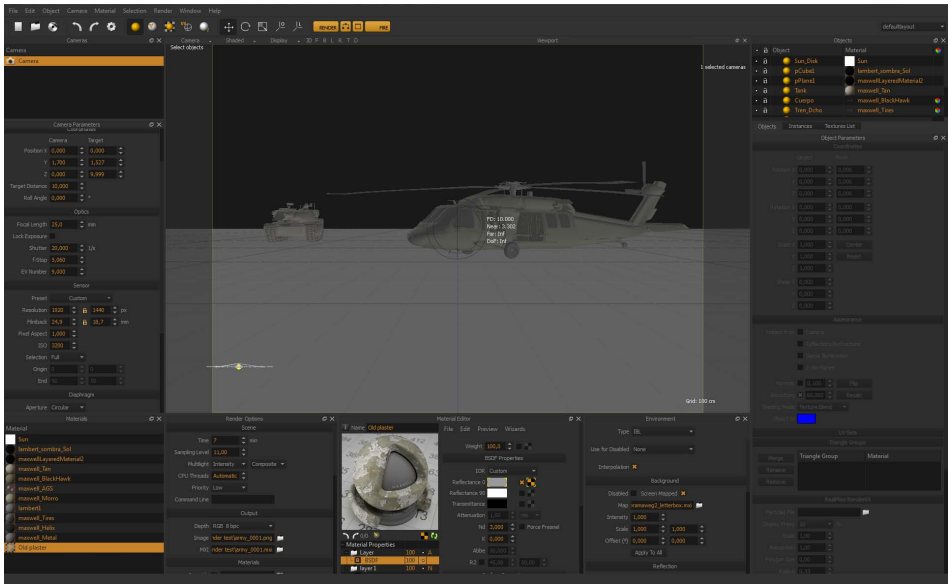
12.01 Interface

The Maxwell Studio UI consists of three main parts: The menu bar, the toolbar, and the panels. The toolbar and the panels can be customized and their size, placement and visibility can be changed.



F.01 Studio main UI

12.01.01 Menu bar

F.01 Menu Bar

- **File:** Open a scene, save, create a new scene, import and export files, import objects and scenes from the built-in library or export a scene using the "Pack and Go" option. The Pack and Go function allows you to copy all textures/ HDR/ IOR files used in the scene, as well as the scene file itself, to a folder of your choice. This makes it very easy to share scenes with other users. Or use the Pack and Go function to quickly organize your scene, making sure you have gathered everything that is needed.

  ☑ *Please note that the Export As option may give you a warning saying the object(s) selected are protected and cannot be exported. This happens if the plug-in that was used to create the MXS file had the Protect Files option on. In this case it is not possible to export files from the MXS*

- **Edit:** Undo, redo, move, rotate, scale objects, edit pivot point, use a world/ local coordinates system, preview the environment in the viewport, scale or rotate the whole scene, open the Preferences window or purge the application history. Some of these functions are also available as buttons in the toolbar.
- **Object:** Clone geometry, create instances, create triangle groups, create UV sets, group/ungroup objects or load RealFlow particles (in .bin or .pd formats).
- **Camera:** Create a new camera, clone the selected one or delete it. Set a camera as Active, and Hide/Unhide, Block/Unblock a camera to prevent accidental editing.
- **Material:** Create, Import, Edit or assign a material.
- **Selection:** Choose between different selection modes such as object, triangle, materials, UV sets or instances. You can also select/ unselect items, hide/ unhide objects, choose a shading mode in the viewport, or perform some selection operations like expand or contract. The Isolate Selection checkbox allows you to display only the currently selected object in the OpenGL viewport, useful for getting a faster feedback in dense geometry scenes. Some of these options are also available as buttons in the toolbar or by right-clicking in a viewport.
- **Render:** Various rendering modes are available:
  - **Render:** Send the scene (full frame or the desired region) to be rendered in the Maxwell.exe application.
  - **Render via Network:** Exports the scene and opens a network Monitor to assist you to launch your scene (full frame or the desired region) in a render farm using the Network System.

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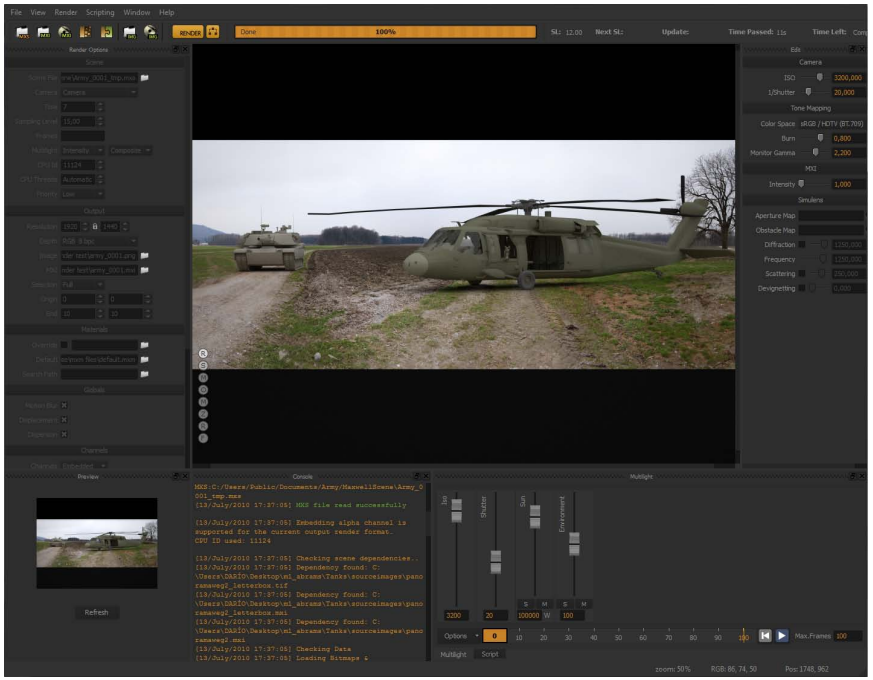
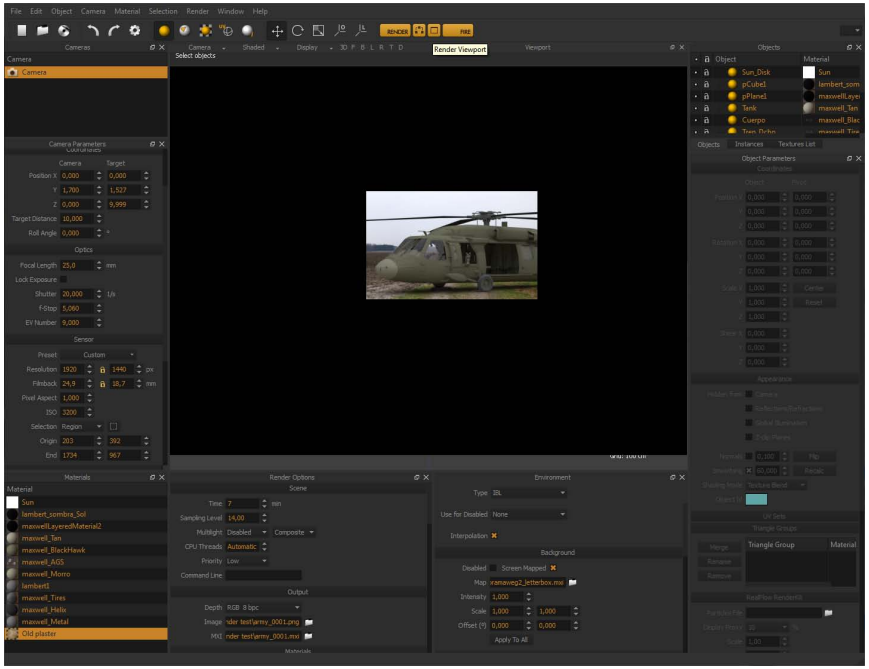
- **Render Viewport:** Launch the render (full frame or the desired region) to be rendered directly in the viewport window.
  To specify if you want to render the full frame at the desired resolution, render a particular region (defined by the Origin and End numeric fields), or blow up a region (defined by the Origin and End numeric fields) at the desired resolution, you have to select the desired option (Full, Region or Blowup) in the active camera (under the Sensor tab).
- **Start/Stop Fire:** Launch Maxwell Fire (the Fast Interactive Rendering window), to get interactive feedback of the changes in your scene in real time, rendered in draft mode.
- **Full:** render the full frame (in the viewport, in the Maxwell application or in the Network depending on the render mode you choose) at the desired camera resolution.



F.01 Full Render in Maxwell application

- **Region:** render the desired region frame, defined by the Origin and End numeric fields or use the rectangular marquee icon (in the viewport, in the Maxwell application or in the Network depending on the render mode you choose).



F.02 Render Region in Studio viewport

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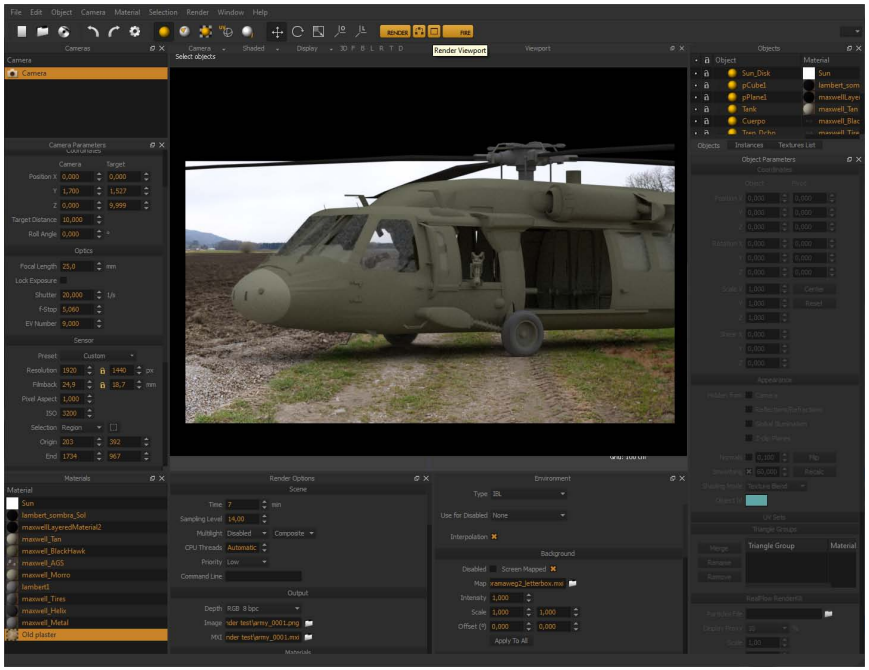
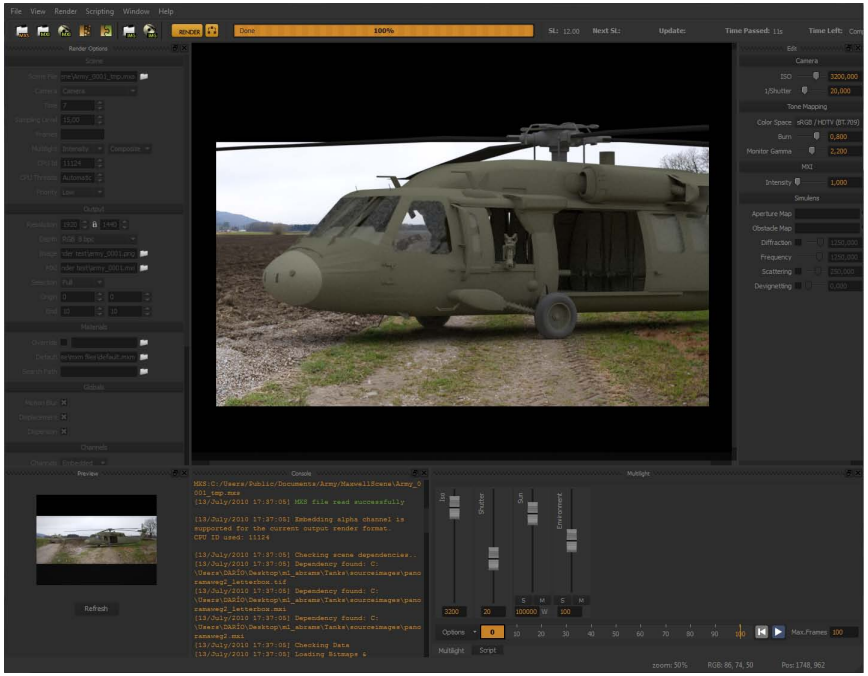
- **Blow Up:** render the desired region frame, defined by the Origin and End numeric fields or use the rectangular marquee icon (in the viewport, in the Maxwell application or in the Network depending on the render mode you choose) but render the selected region at the full frame resolution (for rendering detail close-ups).



F.03 Blow Up Region in Studio viewport



F.04 Blow Up Region in Maxwell application

- **Window:** Load and save your layout, use a layout from a list of pre-set layouts, launch a new viewport, or open any of the panels available in Maxwell Studio. If you want to create your own default layout, save your desired layout with the name defaultlayout.stlay and store it in the Maxwell Render layouts folder. Maxwell Studio will open your layout the next time it is launched.
- **Help:** This menu allows you to access information about your license and the version of the software, open the Maxwell Manual, or access the THINK! tutorial website where you can find hundreds of free (video) tutorials. The License option can be used to load your license file so that Maxwell Render will no longer run in demo mode. Remember that the demo version of Maxwell Render will render with a watermark, at a 800x600 maximum resolution, and has network rendering disabled. There is also a 30-day time limitation.

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12.01.02 Toolbar

F.01 The Toolbar

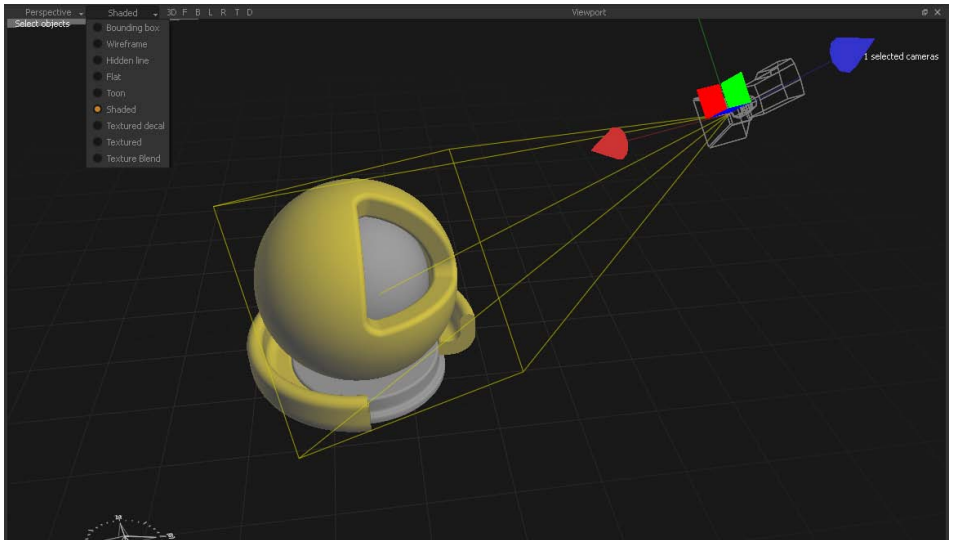
The Toolbar in Maxwell Studio displays a selection of the most commonly-used tools, divided into six categories. Use the icons to:

- Create a new scene, open an existing scene or save the current scene.
- Undo, redo or open the Preferences panel.
- Choose a selection mode: object, triangle, material, UV set or instances.
- Translate, rotate the scene, edit object or pivot or choose between world and local coordinates.
- Set the render mode: in Maxwell application, using the Network, or rendering directly on the Studio viewport. Rendering your scene in the Maxwell application gives you an extra control over the rendering process, as it allows you to control the Multilight sliders, use scripting, SimuLens, etc, and will be the main option for most projects. Sending the scene to be rendered in the Network System allows you to use several computers working together in a render farm.
- Rendering in the viewport gives you feedback of your render directly on your Studio viewport.
- Launch the Interactive Preview (Maxwell Fire) which gives you interactive feedback about your scene, by displaying a great quality preview render of your scene in seconds. This makes it much easier and faster to adjust your materials, adjust the environment conditions, set up the emitters and see the results in real time.

These icon groups are customizable to let you display them in the way you prefer. You can change their sizes using Preferences> General> Icons Size. You can drag sections by their borders on the left side to rearrange their order in the Toolbar. It is also possible to right-click in the Toolbar to choose which buttons you would like to display (File, Edit, Select, Transform, Render, Layout).

12.01.03 Customizing the Layout

Maxwell Studio's layout is fully customizable. To open or close any of the panels you can either go to the Window menu and switch it on or off, or right-click on the title bar of any open panel and choose the panels from the menu. Please note that in order to open another viewport, you have to chose this option from the Window menu, or press the shortcut key Ctrl+1. (The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key).



F.01 Display modes and grid

Moving and docking panels

Panels can be moved to another place by clicking their title bar and simply dragging & dropping them in another area of the layout. The layout will automatically re-shape to allocate the new window. This makes it very fast and easy to configure a layout.

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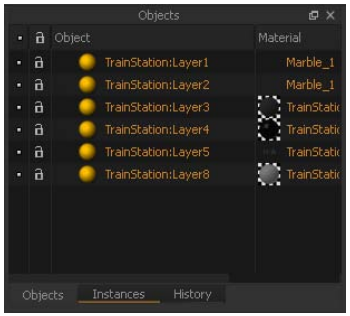


F.02 Docking panels in tabs

Creating tabs of panels
Panels can be grouped together in tabs by dragging and dropping a panel on top of another panel, allowing you to easily switch between panels by clicking on their tabs. Some tabbed panels will switch automatically. For example, if you tab together the Color Picker panel and the Texture Picker panel, the tab will switch automatically to the Texture Picker panel when you click a texture chip in the Material Editor panel.

Detach a panel
Panels can be detached from the main layout by clicking the icon in the title bar. Once a panel is detached, it cannot be re-attached to the layout by moving it; you have to click the detach button again to put it back in the same place it was before it was detached.

Resizing a panel
You can resize a panel by clicking on its border and dragging it. When you move the mouse close to a border the cursor will change to indicate that you can click/ drag to resize it.

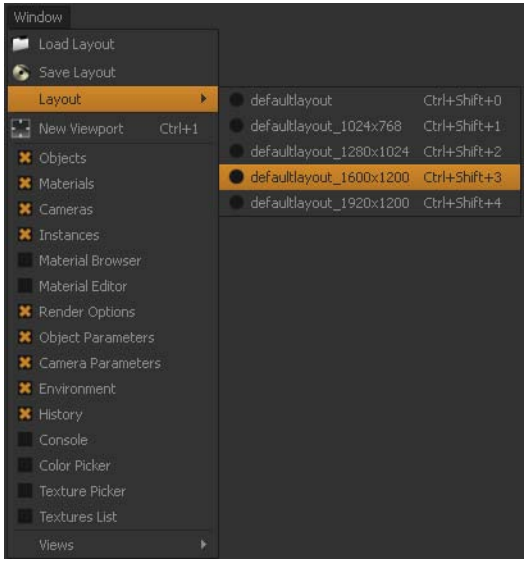
Opening a new floating panel
Open the Window menu and choose which panel you wish to open as a floating panel. Dock it by clicking on its title bar and drag & drop it into an area of the layout. If the panel was previously part of the layout but had been closed, it will instead re-appear where it was placed last in the layout.

Removing a panel
Panels can be removed by clicking the cross icon. The layout always reconfigures automatically, expanding or stretching the other panels.

Splitting a panel
Panels are flexible and can be split horizontally or vertically by dragging and dropping another panel on them. This allows new panels to be added to the layout. This is the usual way to build a new layout.

Saving a layout
Once you are happy with your custom layout, save it using the Save layout option in the Window menu. The file will be saved as a .stlay file.

Opening a layout
Click the Load Layout option from the Window menu and navigate to the folder containing the .stlay file.



F.03 Loading saving layouts

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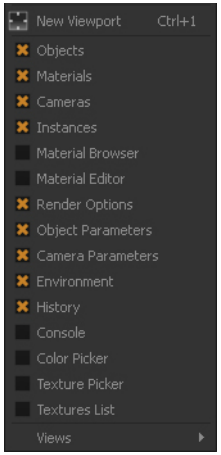
Quick switching between layouts
You can quickly switch between different layouts by using the drop-down list located in the top row of buttons. You can also switch layouts using Window > Layout, choosing from the list of available layouts.
Make sure to save your custom layouts in the Maxwell/layouts directory on your computer so that they appear in the list. You need to restart Studio for a newly saved layout to appear in the list.

Setting a custom layout as default
Saving any layout as "defaultlayout.stlay" will make it the default layout when Studio is launched. It is recommended that you first rename the "defaultlayout.stlay" file in the Maxwell folder if you later wish to reload the original default layout.
A set of layouts comes in a layout folder with the Maxwell installation. These layouts are focused on various specific uses of the software, like mapping, rendering or editing.

12.01.04 Panel Types

Maxwell Studio provides different panels for different functions. The panels can be opened or closed using the Window menu or right-clicking in the title bar of a panel.



F.01 Panel Types

- **Viewport:** Choose for a perspective or orthographic camera viewport.
- **Materials list:** List of materials available in the scene.
- **Material Editor:** Advanced editing of the selected material.
- **Material Browser:** Browse material libraries, or access the MXM gallery.
- **Environment settings:** Physical sky/ SkyDome/ IBL lighting options.
- **Render Options:** General rendering options.
- **Object list:** List of all objects and groups of objects in the scene.
- **Object Parameters:** Parameters of the selected objects or instances.
- **Cameras List:** List of cameras in the scene.
- **Camera Parameters:** Parameters of the selected camera.
- **Console:** Console messages.
- **History:** List of changes made in the scene.
- **Instances:** List of instances for the selected object.
- **Textures Panel:** List of textures in the scene.

Most of the panels are divided into subsections to display the information more efficiently. Click on the section's name to expand that section and click it again to collapse the section. Some panels – like the Camera and Object List panels – are disabled if you do not have a camera/ object selected.
See the list of available panels in the Window menu

Numerical Input
The numerical input can be edited by typing in new numbers or clicking the up and down arrows. You can also use the MMB (middle mouse button) and drag over the up/ down arrows to scroll the setting. Alternatively you can use the scroll wheel of the mouse. Press Ctrl while using the MMB to scroll faster through the numbers.

*The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key.

For numeric fields that are related, such as the Position/ Rotation/ Scale numerics in the Object Parameters panel, you can also type in a value just for X Position, and hold Shift while pressing Enter. This will copy the value you entered to all three position fields. You can also press Shift + MMB when hovering over the up/ down arrows to change all the related fields at the same time.

Right-clicking in a numeric field brings up a menu with the option to set the Decimal Precision. This way you can customize each numeric field to your needs. Some fields may

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not need any decimals at all; others may require 3 or 4 decimals. If you want to move an object in very small increments you can increase the number of decimals.

Using the Viewport and Cameras
The viewports in Studio are OpenGL® based and display all the scene items (objects, cameras, etc.).
You can create as many viewports in a layout as needed. A viewport can be switched to display a 3D/ 2D viewport.

Navigation
These are the basic functions to navigate in the graphical viewports:
- ALT + LMB = Rotate camera around the target origin
- ALT + MMB = Pan camera
- ALT + RMB = Zoom camera in/ out
- ALT + CTRL + LMB = "Slow-mode" – slowly rotate camera around the target origin. The up/ down arrows on keyboard can be used to change how slowly the camera should move in this mode. You can repeatedly press the up/ down arrows to adjust, then use ALT + CTRL + LMB.
- ALT + CTRL + MMB = "Slow-mode" – slowly pan camera.
- ALT + CTRL + RMB = "Slow-mode" – slowly zoom camera in/ out.
- ALT + SHIFT + LMB = Rotate camera target around the camera origin.
- ALT + SHIFT + RMB = Displace camera origin along the look-at direction. This also moves the camera's focal point (camera target), along with the camera.
- ALT + SHIFT + MMB = Roll camera.

* The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key.

Additionally, there are quick navigation options when right-clicking on a viewport:

- **Reset Viewport** will reset the viewport to a default perspective view.
- **Look at Selection** applies to both camera and perspective view and it centers the selection in the viewport without changing the position of the viewer or the camera zoom.
- **Center Selection** centers the current selection (objects and/ or groups) in the viewport.
- **Center Scene** centers the entire scene in the viewport.

2D / 3D Viewports
Maxwell Studio provides perspective and orthographic viewports. The buttons at the top of the viewport allow you to quickly change between views:

- Perspective allows you to change between the perspective/ cameras point of view. When clicked, a menu appears listing the available cameras and perspective views.
- The Shaded option will change the display mode of the window. Please see the Display Modes section below for more details.
- The 3D button can be clicked to change to a 3D perspective view; by default it will show the last active perspective in that window.

Clicking any of the other letters will change the viewport to an orthographic view:

- **T** for top
- **D** for bottom
- **L** for left
- **R** for right
- **F** for front
- **B** for back

Pressing the I key on your keyboard will enable/ disable the information text displayed in the viewports.

Shading Modes
Maxwell Studio provides different shading modes in the viewports. You can choose the appropriate mode by clicking on the display mode menu in the viewport title bar.

The following shading mode options are available:

- **Bounding box:** Only bounding boxes of the objects are shown.
- **Wireframe:** Only wireframes are shown.
- **Hidden line:** Like wireframe, but backfacing polygons are not shown.
- **Flat:** Flat shading.
- **Toon:** Cartoon shading.
- **Shaded:** Smooth shading.
- **Texture decal:** Textures are previewed in the viewport without shading.
- **Textured:** Textures are previewed in the viewport with shading.
- **Texture Blend:** Textures are blended together with opacity values and previewed in the viewport with shading.

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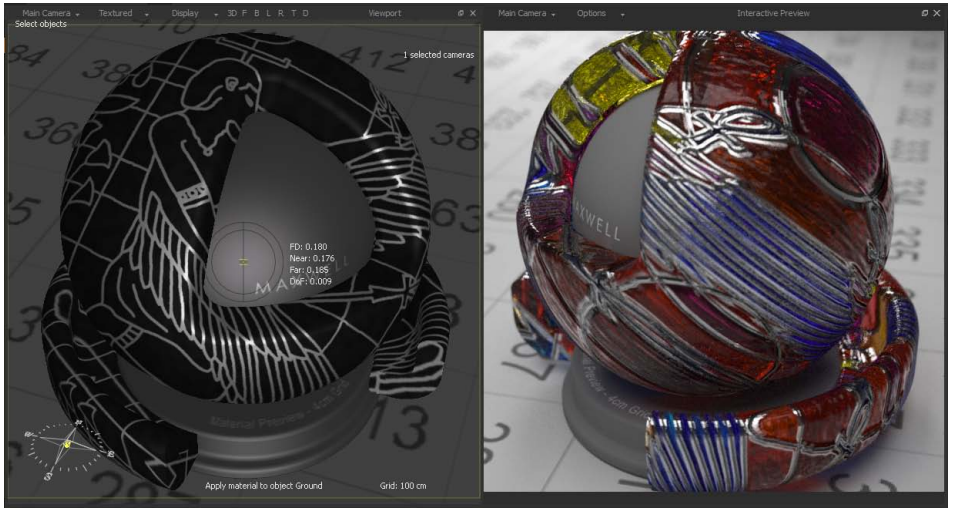
Display
Allows you to hide/show certain info utilities, like scene Info, Sky preview, Grid, Compass, Region and UV Sets.

The Viewport Grid
The grid visible in the 2D and 3D viewports gives you an indication of how big your objects are. It is recommended to use the grid to check if your objects are the size you intended. The 3D viewport has a grid size indicator at the bottom right of the viewport showing the current grid size. There are two ways to display the grid: adaptive and absolute. These options are available in the Preferences> Viewport section.
Adaptive grid will automatically re-size the grid as you zoom in and out of the scene. The grid size indicator will change, providing information about the current grid size. The number shown is the distance between two bright lines in the grid.
Absolute grid allows you to set a fixed size for each grid square and will not change when you zoom in and out.

Note: 2D grids will still show an adaptive grid.

12.02 The Interactive Preview



Interactive Preview en Studio

Studio has an interactive preview mode, Maxwell Fire (which stands for Fast Interactive Rendering), which gives you a completely interactive feedback of your scene, rendered quickly in draft mode.

You can launch it by clicking the Fire button on the Studio icons bar.

You can interactively adjust the materials, the environment conditions, and the intensity of lights or move the camera and adjust its settings.
You can also move objects and lights in your scene whenever you want, although it needs a quick voxelization time to update the scene configuration changes.

On the main bar of the Interactive Preview window you have the following menu tabs:

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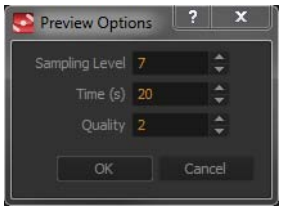
- **Camera selector:** This drop-down lists all the cameras that are available in your scene. Use it to select the camera you want to be rendered in the Interactive Preview. You can freely navigate in the Interactive Preview window with the Studio navigation shortcuts (Alt+LMB to orbit, Alt+MMB to pan and Alt+RMB to zoom) to explore your scene in detail. To revert to the original camera position, select the camera in the Camera selector drop-down.

- **Options** menu that allows you to access some interesting features:

  - Set Camera View: You can freely navigate in the Interactive Preview window with the Studio navigation shortcuts (Alt+LMB to orbit, Alt+MMB to pan and Alt+RMB to zoom) to explore your scene in detail. If you find a view that you like, you can set it to be the camera position. To make your camera take on your interactive preview view, choose the Set Camera View option in the Options tab, and your camera in Studio will move to your current preview view.
  - Isolate Selection: When this option is enabled, only the selected object will be rendered in the Interactive Preview. It is very useful for getting faster feedback when adjusting one particular object. Disable this option to render the whole scene in the Interactive Preview.
  - Save Image: You can save the preview render to disk in any supported image format using this option.
  - Settings: This opens the Interactive Preview settings menu, which allows you to set the quality of the interactive render, by adjusting the target Render Time (for the interactive render) in seconds, the target Sampling Level, and the rendering quality in a 1 to 5 scale, which affects the preview images antialiasing level - lower quality gives you faster and rougher previews. The quality level does not affect the quality of the global illumination or any other lighting or rendering feature.



Preview Option Panel

12.03 Objects List, Instances List and Objects Parameters

12.03.01 Objects List

The Objects List is a panel where the groups and objects in the scene are listed in an Internet Explorer-style interface.

F.01 Objects List

The objects panel is organized into columns, from left to right: Hide/ Unhide, Lock/ Unlock, Object, Material, and Multimaterial.
Each column can be re-sized by clicking on and dragging the column separations. The Hide/ Unhide and Lock/ Unlock icons at the top of the columns can be used to quickly hide/ unhide or lock/ unlock the items in your scene. The material column shows which material is applied to your object/ group and the Multimaterial column shows which objects have multiple materials applied to them.

Right-click in the Objects List to view the available tools:

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- **Assign Material:** Apply a material to a selection of one or more objects and/ or groups.
- **Clone:** Create clones of your current selection.
- **Instance:** Create instances of the current selection.
- **Group:** Create a group from a selection of objects. A pop-up will appear allowing you to name the group. Groups can be nested to create hierarchies. Simply drag and drop a group over another group or object.
- **Ungroup:** Ungroup the objects contained in one or more groups.
- **Group Triangles:** Create a triangle group from a selection of triangles. You can select triangles by clicking on an object and switching to triangle selection mode. The triangle group can be found in the Object parameters panel under the "Triangle Groups" tab. This feature is useful if you want to apply another material just to a portion of an object, in which case you drag/ drop the material over the triangle group listed in the Object parameters panel.
- **New UV set:** Select one or more objects and use this feature to create a new UV set for the object(s).
- **Select all:** All objects and groups will be selected.
- **Deselect all:** All objects and groups will be deselected.
- **Merge objects:** Select two or more objects and choose this command to merge them into one object.
- **Remove:** Delete one or more groups or objects. Note that objects in the group(s) will also be deleted.
- **Rename:** Rename an object or group. You can also press F2 to rename an object or group.
- **Shading Modes:** Set the shading mode in the viewport for the currently selected object(s).
- **Items:** The items menu contains several options:

    - Expand All: Expand all objects and groups.
    - Expand Selection: Expand all selected objects and groups.
    - Collapse All: Collapse all objects and groups.
    - Collapse Selected: Collapse all selected objects and groups.
    - Sort Alphabetically: Sort all objects and groups alphabetically

- **Icon Size:** Set the size of the icons displayed in the object list (Small, Medium or Large).

12.03.02 Instances List

This panel lists the instances of the selected object. Instances can be generated via plug-ins or directly in Studio. Not all the plug-ins support instances; please check the plug-in documentation.
Instances are a great way to save memory when rendering. For example, you could have 1 real object and 10,000 instances of it, Maxwell Render™ will consume the same amount of memory at render time as if it was rendering only 1 real object.
Instances are very suitable for creating vegetation, bricks, furniture or any other geometry that is repeated a lot in your scene.

It is possible to remove material assignments in instances by selecting the material in the Instances List and clicking the "Del" key. Keep in mind that when an instance does not have a material applied to it, it inherits the material of the original mesh.

Some things to keep in mind when working with instances:

- Instances with an emitter material are not supported. At render time the instances will be converted into real objects.
- Motionblur and Displacement are not currently supported on instances.

For more information about Instances see section 12.2.6.

12.03.03 Objects Parameters

When a group or a set of objects are selected in the Object list panel, or an instance is selected in the Instances panel, the Object parameters panel will show the list of parameters that can be changed for that selection. The panel is divided into several sections which can be expanded/ collapsed by clicking on the section title.

1. **Coordinates**
    - Position: X, Y, Z world position of the object and its pivot.
    - Rotation: Euler angles of the object and its pivot.
    - Scale: X, Y, Z scale of the object.
    - Shear: shears the object on the X, Y, Z axis.
    - Center: Set the pivot point to the geometric center of each object.
    - Reset: Reset the pivot of the object to the scene center (0,0,0).

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2. Appearance

- Hidden from Camera: Hide the object from the render view but allow it to contribute to the render calculation (cast shadows, refract etc).
- Hidden from Reflections/ Refractions: Reflected or refracted objects are hidden.
- Hidden from Global Illumination: The object will render but it will not affect lighting.
- Hidden from Z-clip: The object will not be cut by Z-clip planes.
- Normals: Show the normals of the object in the viewport. You can also set their length in the numeric field.
- Flip: This will change the "renderable" side of the polygon by changing the direction of the normal vector. This is relevant for objects that have emitter or dielectrics materials applied to them. An emitter object will always emit light in the direction of its surface normals, so if you find your emitters are emitting light in the wrong direction, flip the normals. For dielectric materials Maxwell Render uses the normals direction of an object to know when a ray has entered and exited the object. If the normals are reversed, flip the normals.
- Smoothing: Smooth objects at render time or do not smooth the object(s) (Flat). The numeric field represents the angle of smoothing. If the angle between adjacent polygons is smaller or equal to this angle, they will be smoothed.
- Recalc: Recalculate the objects' normals. This parameter can be used to remove rendering artifacts due to corrupt normals of an imported object.
- Shading Mode: Set the shading mode for the selected object(s). Please note that you can also set the shading mode in the viewport. The shading mode that will be displayed in the viewport will always be the most "basic" mode chosen. For example, if you set "Bounding Box" (lowest shading mode) as the shading mode for an object in the Object parameter panel, but set the viewport to Shaded mode, the object will be displayed in Bounding Box in the viewport. On the other hand, if you set the viewport to Wireframe but set the object shading mode to Textured, the object will be shown in Wireframe because it is a lower shading mode than Textured mode.

3. UV Sets

Create a new UV set for the selected object, rename it or remove it. It is also possible to edit the parameters of the currently selected UV set.
To edit a UV set, you should set it to something other than Locked mode. You can select several UV sets at the same time and edit their properties:

- Type: Choose the type of UV set needed for the object. There are four types of UV sets available: Flat, Spherical, Cylindrical and Cubic. Imported objects that already have UV sets will have their UV's imported as "Locked". This UV type does not allow for editing. It is also possible to set the current UV set to Locked to avoid editing it by mistake.
- Operator: This option allows you to apply the same transformation to all the selected UV's at the same time, for example if you wish to scale all the selected UV sets by 10%.
- Channel: Specify the UV channel that this UV set will represent. The UV channel is used when applying textures to a material in the material editor, by specifying the UV channel that texture should use. For example, an object may have two UV sets, one spherical (channel 0) and one flat (channel 1). A material applied to this object can use both the spherical UV set and the flat UV set. In the material editor, you can set one texture to use channel 0 and another texture to use channel 1.
- Normalize: This function will make the UV's have the size of 1m, regardless of the size of the object they are applied to. It is similar to checking the "Real Scale" box in the Material Editor Texture Picker, and it is useful to normalize the projectors directly, for example if you already applied a material to the object and you do not want to check Real Scale in the material.
- Adjust: Adjust the position, rotation and scale of the current UV set to the global position, rotation and scale of the object it is attached to.
- Position: This option refers to the position of the UV set relative to the position of the object it is applied to. 0,0,0 means the UV set's pivot is at the center of the object it is applied to.
- Rotation: This refers to the orientation of the UV set relative to the orientation of the object it is applied to. 0,0,0 means the UV set has the same orientation as the object it is applied to.
- Scale: The size of the UV set relative to the size of the object. A scale of 1 means the UV's are the same size as the object. A scale of 0.5 means the UV's are half the size of the object. The scale is initially set to the bounding box size of the object for cubic UV sets.

4. Triangle Groups

This section displays all triangle groups belonging to the selected object. Note that only one object has to be selected for the list to display the triangle groups.
To view the triangles associated with a triangle group in the viewport, make sure you are in Triangle Selection mode and select a triangle group. The triangles will be highlighted in the viewport.

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You can drag and drop a material from the material list onto a triangle group to assign that material to just that triangle group. It is also possible to select a triangle group in the list, and drag and drop a material directly in the viewport. To remove a triangle group, select it and press the Delete key on your keyboard.

Additionally, if you right-click on a triangle group a menu will pop up:

- **Merge:** Merge two selected groups. The material of the first selected group will also be used for the new merged group of triangles.
- **Rename:** Rename a group.
- **Remove:** Remove the triangle groups but not the triangles themselves. Same as the Delete key.

RealFlow RenderKit
Maxwell Render is compatible with RealFlow through the RealFlow RenderKit; the system that allows you to import bin particles from RealFlow and mesh them "on-the-fly" during the render process. This is a smooth and efficient process, enabling you to customize the meshing of the particles before rendering without having to save large meshes to disk, taking up space.

You can either create a RealFlow object from the menu Geometry> RealFlow particles and load a particle bin file in the RealFlow RenderKit section, or you can attach a RealFlow particle bin to an existing object, in the same way.

- **Particles File:** Load the bin file into Studio.
- **Display Proxy, %:** This percentage represents the resolution of the particle cloud displayed in the viewport. The higher this value, the more accurate the proxy in the viewport, but the slower the performance in OpenGL.
- **Scale:** The overall scale used in your RealFlow simulation. This parameter is critical and must be set to the same value that was used in RealFlow to get correct results.
- **Resolution:** Resolution of the fluid in the scene. A good starting point is to set the same resolution that was used in the emitter in the RealFlow scene, but you will have to experiment to get the look you are after.
- **Polygon Size:** The size of the polygons in the mesh. If this parameter is greater than zero the previous parameter's scale and resolution will not have any effect on the appearance of the mesh.
- **Radius:** Controls the blobbiness of the mesh (from 0 to 1). This is related to resolution. If you choose 0, the radius of the particles will be 0.5 times the resolution and if you choose 1, the radius will be twice the resolution.
- **Smooth:** The smoothness of the mesh. To assign smoothness to the mesh, put in a value greater than zero (values range from 0 to 1). A good starting point is 0.3.
- **Core:** Isolate the core of the fluid from the rest. The range of values goes from 0 to 1.
- **Splash:** Isolate the splashes from the rest of the fluid body. The range of values runs from 0 to 1.
- **Max Velocity:** When motion blur is active, this parameter allows you to define the maximum velocity of particles which will be affected by motion blur - in other words, it has a clamp effect over the motion vectors. Motion blur is controlled by the Shutter parameter and Render Globals settings.
- **Flip Normals:** Invert the face normals of the mesh.
- **FPS:** Must be set to the frame rate in the scene: 24, 25, 30, etc.
- **RealWave File:** Allows you to load the sd file from the RealWave surface to mesh it with the loaded file sequences.
- **Tessellation:** The level of tessellation of the RealWave mesh. The RenderKit tessellates the RealWave mesh internally and indicates the number of particles per polygon.
- **Motion Blur and Motion Blur Coef:** Allows you to enable the motion blur effect, and set a multiplier of the effect.

12.03.04 Working with Objects

Importing Objects
Currently, the supported file formats are: MXS, OBJ, STL, LWO, NFF, XC2, DXF, 3DS, XML (AllPlan 2007), PLY, DAE, FBX and DEM (ascii DEM and SDTS digital elevation models). Some of these formats only store one single object while others support any number of objects. Maxwell Render requires these formats to provide 3D polygonal data as triangles. Other geometry formats are not supported.

☑ *Note: Importing DEM files*
Digital elevation files are supported in two different formats: Ascii USGS DEM and USGS SDTS DEM datasets.
• Working with Ascii USGS DEM datasets:
These datasets come in the form of compressed .gx files.
To import it into Studio, uncompress the file and rename the extracted file to have the extension .dem.
Import the resulting .dem file into Studio.

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Example (in Linux):
gzip -d aberdeen-e.gz
mv aberdeen-e aberdeen-e.dem

You can download some examples of these files in this link:
http://dds.cr.usgs.gov/pub/data/DEM/250/

- *Working with USGS SDTS DEM datasets:*
These datasets come in the form of compressed .tar.gz files. Remove the gzip compression to get a .tar file. Rename the .tar file to have the extension .dem.
Import the resulting .dem file into Studio.

Example (in Linux):
gzip -d 30_1_1_965202.tar.gz
mv 30_1_1_965202.tar 30_1_1_965202.dem

You can download some examples of these files in this link:
http://thor-f5.er.usgs.gov/sdts/datasets/raster/dem/dem_1997/

An alternative to importing geometry into Studio is to save an MXS scene with the Maxwell Render plug-in for your application and importing that scene into Studio.

There are three ways to import objects into Studio:

1. Use the menu command File> Import.
2. Right-click in a graphical viewport and choose Import.
3. Drag and drop an object from your file explorer into the object list panel or viewport.

When Maxwell Studio saves the scene, the geometry is packed in an MXS file and therefore the original object files are no longer needed.

Renaming Objects
Select an object in the Object List panel and press F2 to rename it.

Replacing Objects
If you need to replace an object in the scene with an updated one, you can simply import it again and Maxwell Render will recognize the object with the same name that is already in the scene. It will show you a pop-up asking you what to do with the new object.
This is a very practical feature, as the geometry of the objects can be changed without removing the material properties.

Using Pre-set Object Libraries
It is also possible to load any of the pre-set scenes and objects available with the installation from the menu File> Library.
Users can also create their own objects and scenes and make them available from the File> Library menu by saving them in one of the Library subfolders in the Maxwell installation folder. They will then be available from within Studio for quick loading.

Selecting Objects
Objects can be selected in the 2D/ 3D viewports by clicking single objects with the left mouse-button or dragging over a region with the left mouse-button pressed. Selected items will be highlighted.

- **Shift + Left click:** Select additional objects.
- **Ctrl + Left click:** Deselect the object.
- Press **Esc** to deselect all objects.

Objects can also be selected in the Object List panel. Shift and Ctrl can be used as with the viewport selection.

*The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key

☑ *Note: If an object with motion blur is imported and selected, it will display motion blur vectors.*

Additional options for working with object selections are available when right-clicking in the 2D/ 3D viewport or in the Object list panel:

Move/ Rotate/ Scale
To move, rotate or scale an object, you should first select the object. You can edit one or more objects/ groups at the same time. Switch to Object Editing mode using the icons in the upper toolbar or using the keyboard shortcuts W (move), E (rotate), or R (scale).
You can move, rotate or scale the selected object by dragging the axis or using the numerical inputs in the Object Parameters panel. For the numerical inputs, press the middle mouse button while hovering over the up/ down arrows, and drag the mouse up/ down to interactively change the values. Additionally you can use the mouse scroll wheel or hold down the Ctrl key to change values in larger increments.

* The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key.

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Note: Avoid using the numerical inputs to change transform values when you have multiple objects selected, because all objects will then snap to the same value that you are changing in the numeric input.

Selection Modes
A variety of selection modes is accessible through the icons in the main toolbar or with the keyboard shortcut "T". By default, the selection mode is set to "Object".

- **Object selection:** Select objects.
- **Triangle selection:** Select triangles. Only triangles of already-selected objects will be selected.
- **Material selection:** Select the material assigned to an object or surface. The material will be selected in the Material list panel.
- **UV set selection:** Select UV sets. To make the UV set visible in the viewport, switch first to UV set selection mode, then select the UV set from the UV Sets section in the Object Parameters panel. It will then appear in the viewport allowing you to use the move/ rotate/ scale gizmos, just like with a regular object.
- **Instance selection:** Select instances. Select an object, then choose Instance selection mode to select the instances in the viewport.

Extra features to improve the triangle selection process are available from Selection> Polygon Selection and Selection> Polygon Selection Mode.

Selection menu
- **+ Key:** Expand the selection to the neighboring faces. Pressing the "+" key several times will propagate the selection to the next neighboring faces of the current selection. The faces you wish to select must be connected.
- **- Key:** Reduce the selection to the inner neighboring surfaces. This is the opposite of the "+" key.
- **/ Key:** Expand the selection to cover all connected faces.
- *** Key:** Invert the current selection.

- **F8:** Set Expand To Facet selection mode. This will select facets instead of triangles.
- **F9:** Set Raycast Polygon selection mode. This will select both front and back faces of an object.
- **F10:** Set Front-face Polygon selection mode. This will select only front-facing triangles.
- **F11:** Set Paint Polygon selection mode. This allows you to drag the mouse to paint the selection over the surface. Use the Shift key to select more triangles while dragging the mouse.

12.03.05 Working with Groups and Hierarchies

Objects can be grouped by selecting the objects and choosing "Group" from the right-click menu in the viewport, or from the Object List panel. Objects can be moved from one group to another, or removed from groups by dragging them out of the group in the Object List panel.

F.01 Groups

Objects can also be parented to other objects, dragging and dropping them, and groups can be parented to other groups. In this way you can easily organize your scene. The hierarchy depth is unlimited. More options for working with groups and hierarchies are available via the right-click menu in the Object List panel.

Note: Depending on the type of selected item, some of these options will not be available.

Groups are transformed using a single pivot point. Select the group and press the Move/ Rotate/ Scale button. A single set of transform handles will appear.

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Commands available from the "Items" section in the right-click menu:

- **Group:** Select more than one object and select this option to group the objects.
- **Ungroup:** Select one or more objects in the group and use this option to remove the objects from the group. The objects will be placed outside the group, they won't be deleted from the scene.

Sorting options:

- **Expand All:** Expands all the groups in the object list.
- **Expand Selected:** Select one or more groups and select this option to expand the group(s).
- **Collapse All:** Collapse all the groups in the object list.
- **Collapse Selected:** Select one or more groups and select this option to collapse the group(s).
- **Ascending Order** and **Descending Order:** Sort the objects alphabetically in ascending or descending order.

Creating Hierarchies
Besides creating groups of objects, Studio also offers the following functionality for organizing your scene objects:

- Placing objects under other objects
- Placing groups under other groups
- Placing groups under other objects

The hierarchy depth is unlimited. You can for example have a group under an object and that object can be part of another group and so on. You can organize the scene hierarchy by drag & dropping objects and groups.

12.03.06 Working with Instances

Instances can be selected and manipulated in the viewport just like regular objects. Use Object Selection mode to select the object that has instances attached to it. Then click the Instance Selection mode button and select the instance(s) in the viewport to manipulate them. By default an instance inherits the material of its parent object, but you can apply another material to instances by dragging and dropping a material from the material list to the instances in the Instances panel.
The following options are available when right-clicking in the Instances panel:

- **Rename:** Rename an instance.
- **Remove:** Delete the instance.
- **Display Proxy (%):** Specify how many instances should be displayed in the viewport, by percentage. This is useful if you have an object that has thousands of instances attached to it, and displaying all of them in the viewport will slow it down considerably. If you set the Display Proxy to 10% and you have 100 instances, every 10th instance will be displayed, still allowing you to get a good idea of where the instances are placed.
- **Display Mode:** "None" will not display any instances, "Selected objects" will display the instances of only the selected objects, and "All" will display all instances in the scene no matter the object selection.
- **Shading:** Set the viewport shading for instances. By default it is set to Bounding Box.

It is possible to remove material assignments in instances by selecting the material in the Instances List and clicking the "Del" key. Keep in mind that when an instance does not have a material applied to it, it inherits the material of the original mesh.

12.03.07 Merging Objects

Select two or more objects, right-click in the Object List panel and choose "Merge Objects". The separate objects will be merged into a single object. This is useful to simplify your scenes (merge for example all objects that share one material), or to merge emitters to reduce the number of Multilight sliders. Please note that instances attached to the objects that are merged will be deleted.

12.04 Cameras and Camera Parameters

The Maxwell Render camera is designed to work like a real camera so it is important to understand some photographic concepts. If you are unfamiliar with photography, please read the chapters "Focusing the Camera" and "Depth of Field" to get an idea of how these concepts will affect your render.

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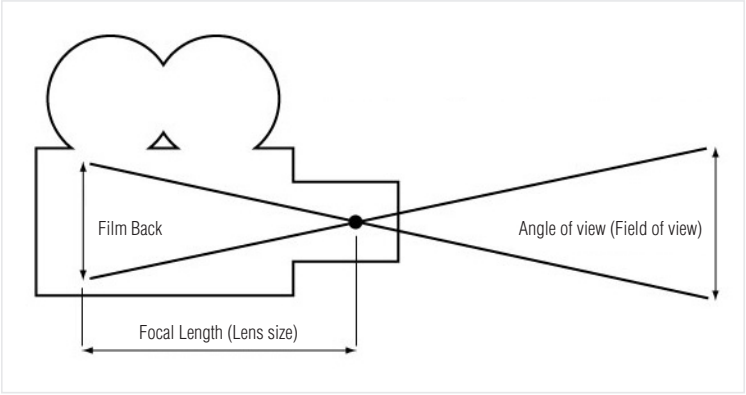


F.01 Camera concepts

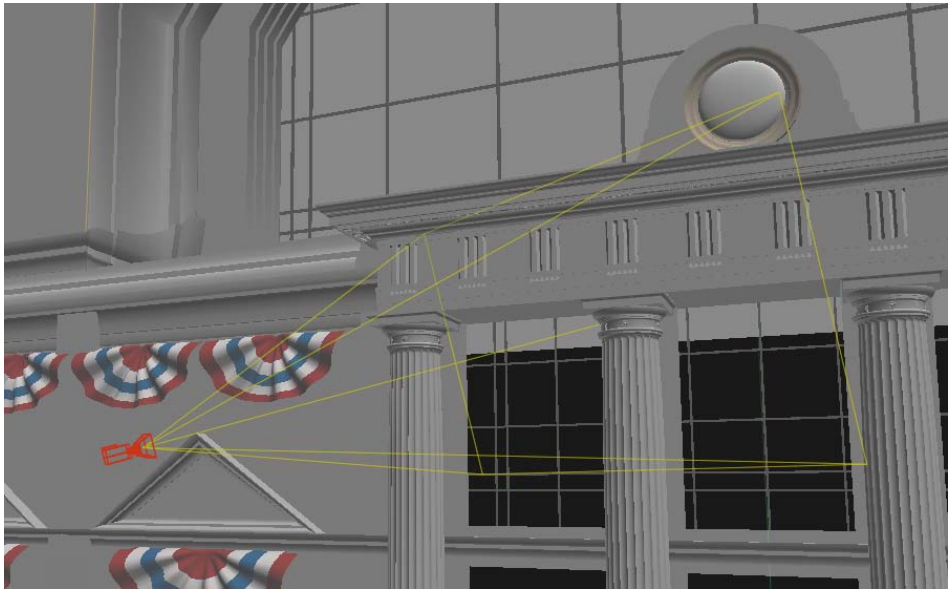
By default Maxwell Studio has a standard perspective visualization mode that acts like a camera, but without all the possibilities of a real Maxwell camera. It is not always necessary to create a camera for your scene, but we do recommend it. It will give you more control over the final look of the image.
Use the viewport menu (right-click in the viewport) and choose "New Camera", or press CTRL + Shift + C, or right-click in the Cameras List panel and choose "New Camera". This will create a camera with the point of view of your current perspective view. You can create as many cameras as you want.

* The Ctrl key in Windows corresponds to the Cmd key in Mac OSX, so wherever the Ctrl key is used on a shortcut, Mac users should use the Command key.

Once a camera has been created, the camera frustum is displayed in the viewport as a thin yellow frame. To switch to a camera viewport, click the Viewport Switch icon in the upper left corner and choose the desired camera or double click on the camera in the Cameras List panel.

Camera frustum (Yellow frame)
The camera frustum is adapted according to the resolution of the image set in the Camera Parameters panel. When the render is launched from the camera view, only the region inside the frustum is rendered. The same applies when you launch a viewport render.

Selecting a camera in the Camera List panel will display the properties of that camera in the Camera Parameters panel.



F.01 Camera Frustum

Moving a Camera
Switch the viewport to "Camera View" and rotate, pan or zoom the view as explained earlier (ALT + mouse). This mode only affects the origin of the camera. In order to pan or rotate the camera as well as the target of the camera, use the shortcut ALT + SHIFT + mouse.
The camera can also be moved using its translate handles. Select the camera from the Camera List panel, and press the move icon from the top row of icons. The translate handles appear and you can move the camera without moving its target.

You can use the '**L**' key on your keyboard to go through different camera move modes. By default only the camera will move when using the transform handles.

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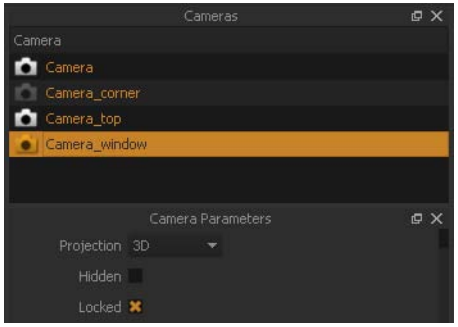
Press **L** once to only move the camera target. You will see the text "Editing From" change to "Editing To" at the bottom of the viewport.
Press **L** again to return to the default camera mode where you are only moving the camera.
Press **L** once again to move both the camera target and the camera itself. You are now "Editing From-To".

12.04.01 The Cameras List panel

The Cameras List panel lists all the available cameras in the scene. To select a camera from the Camera panel, just click on its name. Once selected, you can move or rotate the camera or edit its particular parameters using the Camera Parameters panel.

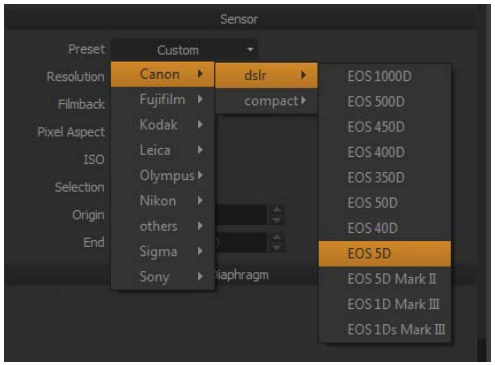


F.01 Camera list

Double-click on a camera name to make it the active camera. Right-clicking in the Cameras panel shows a contextual menu where you can create, rename, delete, block/ unblock, hide/ unhide, or clone cameras. There are also sorting order and icon size options.

12.04.02 The Camera Parameters panel

From the Camera Parameters panel you can edit the specifics parameters of a camera. Most of the camera parameters are related to those of a real photographic camera. For more detailed information about concepts of photography and how they relate to the Maxwell camera, please see the Maxwell Render Cameras chapter 5.



F.01 Real Camera presets

The cameras parameters are categorized in several sub-sections:

- **Type:** Set the camera to perspective or orthogonal. You can also hide or lock your camera.
- **Coordinates:** Set the camera and target position, or point to a position you want to set the camera to. You can also set the Focal Distance (the distance from the camera to the camera target) and the Roll Angle (the rotation of the camera around its Z-axis).
- **Optics:** Set the specific parameters of the optics you want to use in your render, such as Focal Length to adjust the aperture of vision. You can also control the exposure by setting the Shutter and f-Stop separately, or use the Lock Exposure and EV Number. If you enable Lock Exposure while you change the Shutter or f-Stop, Maxwell Render adjusts the other parameter to ensure the image maintains the same exposure level.
- **Sensor:** Specify the settings of your film, such as Resolution (frame size in pixels), Film Back (which defines the film type by defining the size of the film window), Pixel Aspect ratio, and the ISO (light sensibility of the film). You can also specify if you want to render the full frame at the desired resolution, render a particular region (defined by the Origin and End numeric fields), or blow up a region (defined by the Origin and End numeric fields) at the desired resolution, you have to select the desired option (Full, Region or Blow up) in the active camera (under the Sensor tab).
- **Diaphragm:** The diaphragm in a camera controls the aperture of the window and thus controls the amount of light that reaches the film. This parameter allows you to

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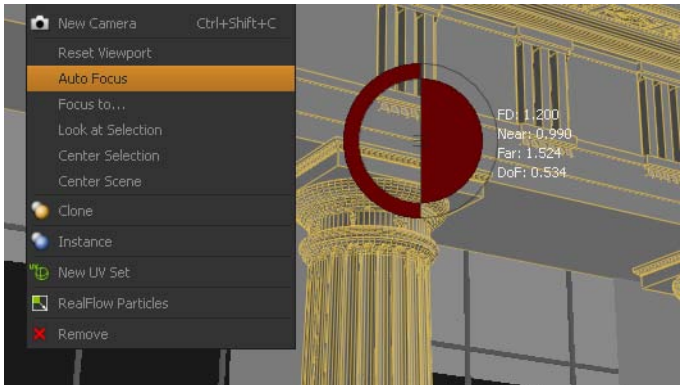
control the shape of the diaphragm aperture (circular or polygonal), the number of the blades and its angle.

- **Rotary Disk Shutter:** Control the Shutter Angle (which controls the proportion of time that the film is exposed to light during each frame interval) and the Frame Rate (number of frames per second). Both concepts are related to the motion blur, or blurred perception of objects in motion.
- **Z-clip Planes:** Z-clip planes allow you to cut away parts of the geometry in a render by specifying the near and far clipping planes of the camera. This enables you for example to move the camera outside a room, and cut away the wall facing the camera so you can still get a render as if the wall did not exist, although the actual render will take the wall into account and produce proper lighting. The Z-clip planes can be previewed either by looking through the camera in the viewport (you will see the objects being clipped as you move the Z-clip planes) or looking in a perspective view which will show the red (near plane) and blue (far plane) rectangles.
- **Shift Lens:** The Shift lens functionality of the Maxwell camera allows you to shift the lens of the camera in order to move the image that falls on the virtual film plane up/ down or left/ right. This is useful for architectural type renders where you want to keep some lines of the building parallel, making a two-point perspective. To properly use Shift Lens, the camera and camera target need to be at the same height, that is, the camera needs to be perfectly level, just like a real world shift lens/ camera.

12.04.03 Focusing the camera

Maxwell Studio has two functions - "Auto focus" and "Focus to" – designed to help you to control the focus of the camera. You can find these options by right-clicking in the viewport.



F.03 Focusing the camera

Auto focus
Automatically focus on the target point (what the focus indicator sees in the viewport). You can also press the F key to auto focus. The camera focus indicator must be over an object for the auto focus to work correctly. In addition, for the Auto focus and Focus to options to work correctly, make sure you are not in Bounding Box or Wireframe shading modes.

Focus to
Choose this option and then click on any object in the viewport. The clicked object will be in focus. Alternatively, you can use the Focal Distance feature from the Camera Parameters panel to manually adjust the focus. Remember that the camera target represents the point where the image will be in complete focus. You can use a perspective viewport to see where the camera target is when making adjustments to the Focal Distance.

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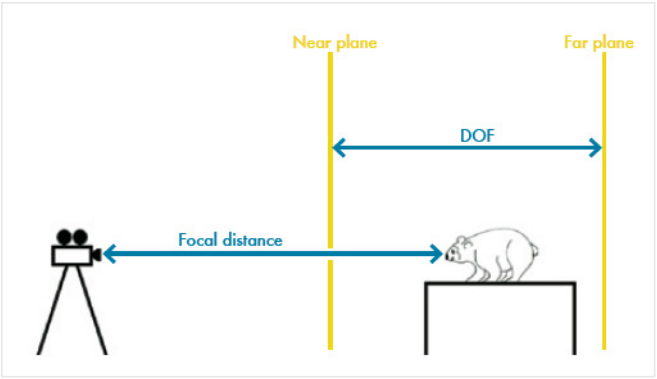
12.04.04 Depth of Field (DOF)

Related to the focus concept, Depth of Field is one of the most important concepts in photography.



F.01 The camera is pointing to the interest area

The focal distance should be the distance from the camera to the object in order to get a perfectly focused image. The near and far planes define the DOF area. Inside the DOF area, all objects are in focus.

The most important camera parameters to remember regarding the DOF are the f-Stop and Focal Length.

- The Focal Length of a lens refers to the distance between the lens and its focal point. The focal point is where the light will be focused, usually where the film is. The focal length of a lens determines the field of view (FOV), or how much you see of your scene, and also the DOF. A small focal length lens (15-24mm) is said to be a wide-angle lens because it captures a lot of the scene (it has a wide FOV), and its DOF is wide too: almost all the objects in the scene will be in focus. A large focal length lens (80-200mm) is said to be a telephoto lens. It acts like a binocular, "zooming" in to a particular area of your scene. It has a small FOV and the DOF will be very narrow too: only a small portion of your scene will be in focus. Which focal length to use is completely up to you and depends on your needs. An architectural scene may need a wide-angle setting to capture more of the scene and make sure everything is in focus. A larger focal length can be suited for product photography or characters because a wide-angle lens tends to distort the objects that are close to the camera and you may want to avoid this in certain cases.
- The f-Stop indicates how opened or closed the diaphragm is. The diaphragm is a thin opaque structure with an opening (aperture) at its center. The diaphragm stops the passage of all light except for the light passing through the aperture. The diaphragm is placed in the light path of a lens, and the size of the aperture regulates the amount of light that passes through the lens. The smaller the f-Stop (1.8, 2.2, 2.8) the narrower the DOF, so only a small area of the image will be in focus.

The Maxwell camera has a visual focus indicator that provides information about the focus conditions of the target. When the camera moves, the focus indicator changes according to the distance from the camera to the objects. The focus indicator is composed of two circles and a rectangular indicator in the center of the camera. When the target object (the central point of the circles) is exactly in focus, the rectangular indicator turns yellow, otherwise it remains black.
A black rectangular indicator does not necessarily mean that the render will be out of focus, it also depends on the total DOF. To measure if the camera target is inside or outside the DOF distance, the circles use blue or red colors. When the circle turns red, it means that the specific target area is beyond the far plane. Conversely, when the circle is blue, the target area is located in front of the near plane.
Areas in red and blue are in "out of focus" zones. Transparent areas are in focus. The yellow mark is the exact focal point.

Shortcut: Press the "**I**" key to disable or enable this information in the display.

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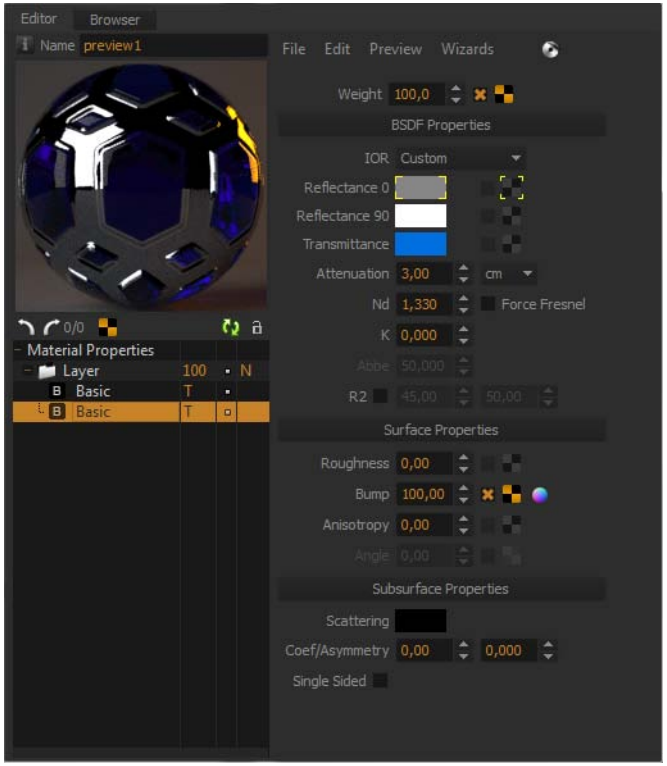
12.05 Materials Editor, Material List and Material Browser



F.01 The Material Editor

12.05.01 The Material Editor

The Material Editor inside Studio has the same capabilities as the Material Editor standalone. It is designed to provide you with full control to create your materials using multiple layers, combinations of different surfaces (BSDFs) inside each layer, add emitter components, displacement, coatings, etc.

For a fuller explanation of Maxwell materials, see Chapter 10.

As in the Material Editor standalone, the material preview window allows you to get a quick preview of the material while you are editing it. When you are changing your material parameters, double-click in the preview sample image to refresh the preview with the new parameters, or click on the Refresh Preview button (green double-arrow icon), and Maxwell Render will compute a preview of your material. During the preview, the green icon will be replaced by a red square icon, to indicate that it is calculating your preview.

This Material Editor has also **Maxwell Fire** capabilities, giving you a constant interactive preview of your material.
To enable **Maxwell Fire** on your Material Editor, simply press the lock icon. While this icon remain locked, your preview will be fully interactive, displaying the changes in the material in real time, giving you extremely precise control over the material you are creating.

Two different qualities are available for this interactive preview: Draft and Production quality.
You can also set the rendering time and sampling level for the material preview to be calculated.

These preview options (including the preview sample scene used for rendering the material) are accessible by right-clicking in the preview sample image or from the Preview menu in the Material Editor.

> ☑ *Note: When **Maxwell Fire** is enabled in the Material Editor (lock icon enabled), the interactive preview is disabled on the Maxwell Studio main viewport, to give priority to the material creation.*

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12.05.02 The Materials List

F.02 The Material List

All the materials currently loaded in the scene are listed in the Materials List, including those that are not assigned to any object.

If a material has already been previewed in the material editor, a smaller version of the preview thumbnail will appear next to it. If the material has never been previewed, an icon with a N/A text will appear next to it.

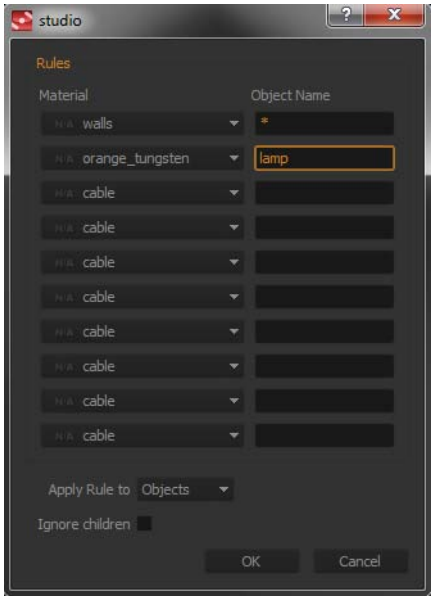
Other than using the Materials List to list all the materials in the scene, it can be used to assign materials to objects. To assign a material to an object, just drag the material name over the object in the Objects List, over the object itself in the viewport, or over a selected triangle group in the viewport.

You can access the contextual menu by right-clicking in the Materials List panel. Use this menu to easily create, import, clone, rename, or remove materials. You can also create emitters, select the object or triangle that has a material is assigned to it, add/ remove assigned triangles, or automatically reload a preview of the selected materials. There are also sorting order and icon size options.

You can even assign materials to your objects automatically using the **Assign by Name** option, by right-clicking on the Materials List.

Use the combos to choose the material(s) to be assigned, and type in the blank fields the name of the object(s) that will receive each material.

You can create you own rules like the one in the following example:



Assign by Name

In this example, the material "walls" has been assigned to all the objects in the scene (notice the "*" notation), and the material "orange_tungsten" has been assigned to any objects that have the word "lamp" in their names.

In this way you can perform massive material assignments with just one click.

You can save the rules you've created to a .mxrul text format, to be applied to another scene, by using the Load and Save Rules icons.

> ☑ *Tip: To keep your MXS files tidy and clean we recommend you to remove unused materials before rendering, using the Remove Unused option. This way Maxwell Render will not spend time looking for textures of unassigned materials.*

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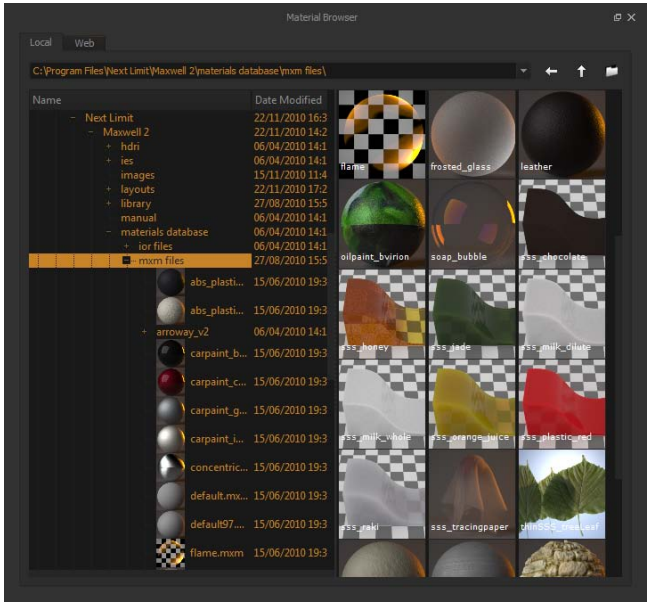
12.05.03 The Material Browser

This panel provides a way to browse the Maxwell materials available on your system. For every MXM file found in the material database, the material browser shows a small preview of the material. Within the Maxwell installation folder there is a material database that you can browse. If you have set a material folder in your Studio preferences (Edit> Preferences> Paths), the Material Browser will open in that folder.



F.03 The Material Browser

Assigning/ adding materials from the browser is done by drag and drop, in one of three ways:

a. Drag and drop a material from the Material Browser onto a selected object or group of triangles in the 3D/ 2D viewport. This action will add the material to the current scene and assign it to the object/ triangles.
b. Drag and drop a material from the Material Browser onto the Materials List (from the browser in Studio or from the browser in MXED). The material is added to the list, but not assigned to any object.
c. Drag and drop a material from the Material Browser into the Material Editor over another material you are currently editing. It allows you to embed the new material in another layer to mix or combine them.

A material can also be dragged from the Materials List into the Material Browser, which is an easy way of creating your own material libraries. It is also possible to select several materials at once and drag them to the Material Browser.

Browsing the MXM Web Gallery

F.04 Search in MXM Gallery

Click this icon to search for a material in the entire online MXM Gallery database, from within Maxwell Studio. This gives you access to thousands of free materials, just a few clicks away, ready to be used in your scenes.

Use the Search field to type in a material name and the results of your search will be displayed in the window below. Use the Advanced Search to specify keywords, search by color, and specify a category or displaying options. The window below will show you the materials that match your searching criteria, their thumbnails, and some specific data such as rating, the creator's name and the upload date. Click on the thumbnail to display a bigger version. Drag the desired material to the Materials List or Material Editor, and the material will be downloaded automatically, unzipped, and added to your scene. You can also drag it over an object or triangles group to automatically assign it to your objects.

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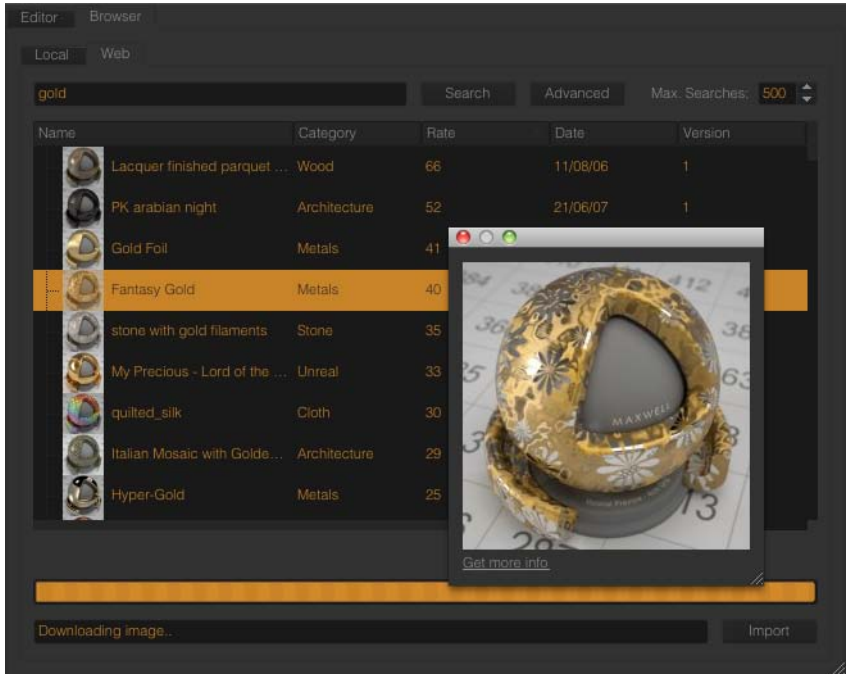
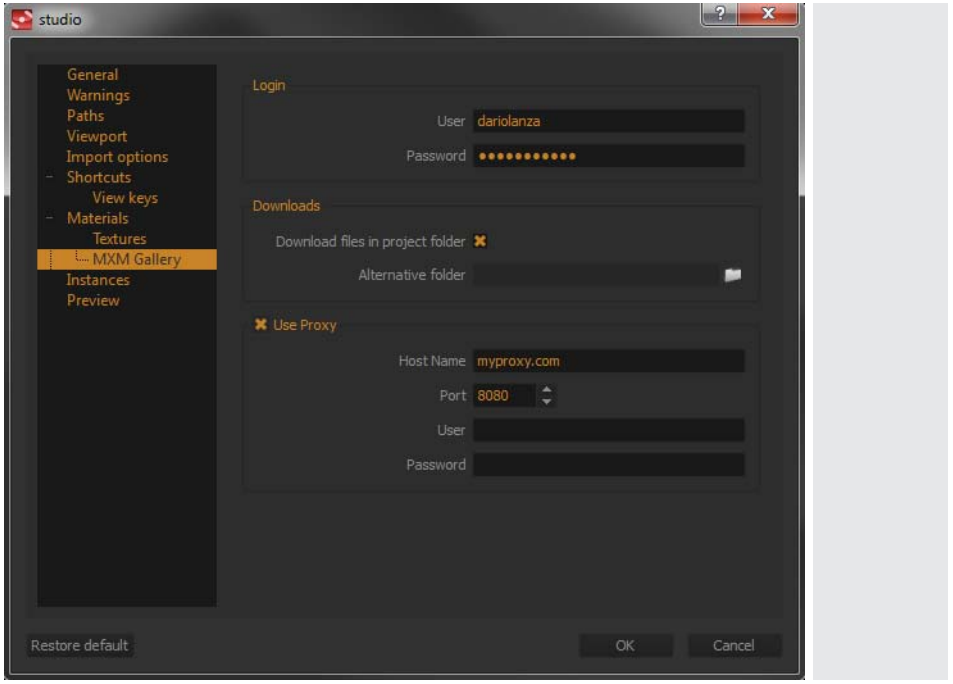


In the Preferences panel, on the Materials> MXM Gallery section, you must set your MXM Gallery user account (username and password) – which are needed to download materials from the MXM Gallery – and specify the folder where these materials are going to be stored. By ticking the "Download files in project folder" option the materials will be downloaded to the same folder where the MXS file is located.



MXM Gallery Preferences

If you are connecting to the internet through a Proxy, you must set the proxy Host Name, Port, Username and Password through Preferences>MXM Gallery.

Ask your IT manager about these settings in case you have any query about your network configuration.

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12.06 Render Options panel

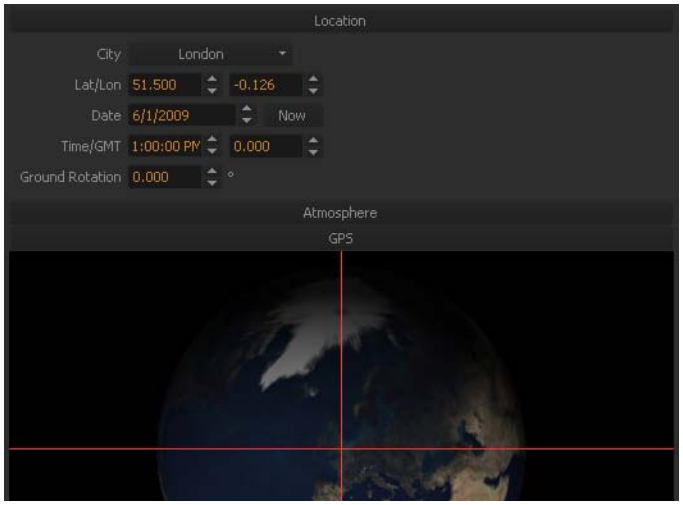
This panel contains a variety of settings to control the rendering process, such as time, SL and output paths and formats. These controls are described in-depth in Chapter 8.

Tip: The Browse Folder icons in this section have drag and drop capabilities, allowing you to copy a file's location simply dragging a folder icon over another.

12.07 Environment panel

This panel provides settings to configure the environment of your scene. You can choose from No Environment, Sky Dome, Physical Sky and Image Based Lighting (IBL). These settings are described in-depth in Chapter 7.

Sky Globe



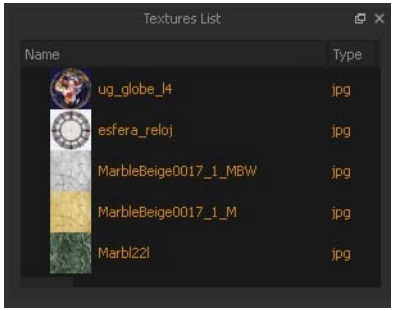
F.05 Sky Globe

One feature that is exclusive to Studio and not available in all plug-ins is the interactive Sky Globe. Some plug-ins with unrestricted SDKs have implemented the Sky Globe feature, like Rhino or SolidWorks.
The Sky Globe allows you to interactively rotate the Earth in the display to change to a different location. Use Alt + LMB to rotate and Alt + RMB to zoom in/ out.

The shortcut key K enables or disables the sky representation in the viewport. The interactive preview of the sky in the Studio viewport will give you a very good indication of what it will look like in the final render. It will change its illumination/ coloration based on location/ time and it will also change if you adjust any camera setting that affects how much light reaches the "film" (ISO, f-Stop, Shutter speed).

The viewport shows the geographical directions (N, E, S and W) by means of a compass located in the bottom left corner. The sun is represented by a small yellow sphere. When the sun is below the horizon, the yellow sphere fades to black.

12.08 Textures List, Texture Picker and Color Picker



F.06 The Textures List

Textures List

This panel lists all the textures that are used in the scene. It displays useful information about your textures, such as type, color depth, size (resolution) and location on disk.

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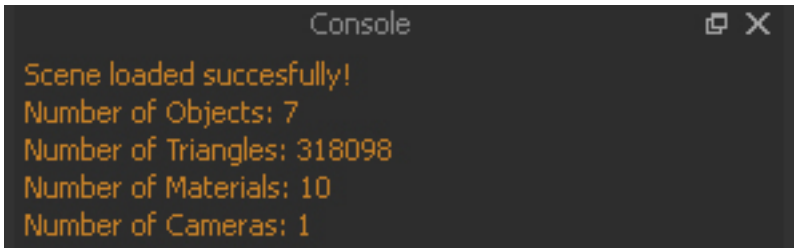
Textures Picker
This panel allows you to edit a particular texture, adjusting brightness, contrast and saturation, or change the color of the tiling of the texture on the object. These settings are described in-depth in Chapter 10.

Color Picker
This panel allows you to pick a color in RGB, HSV or XYZ formats and is described in-depth in Chapter 10.

F.07 Color Picker

12.09 Console and History Panels

Console Panel



F.08 Console panel

This panel provides feedback when running certain functions in Studio and shows scene data. Any error messages or warnings are also displayed in the Console window.
If you experience any problems with your scene, first check this panel for information on what might be the problem.

History Panel

History
<empty>
Set camera: Perspective active in viewport:Viewport 0
Rotate from camera Perspective
Camera Pan camera Perspective
Camera Zoom Wheel camera Perspective
Rotate from camera Perspective
Camera Zoom Wheel camera Perspective
Camera Pan camera Perspective
Camera Zoom Wheel camera Perspective
Camera Pan camera Perspective
Rotate from camera Perspective
Set camera: Camera active in viewport:Viewport 0

F.09 History Panel

The History panel records almost all edits you make in Studio and allows you to go through the list of changes. Just select one of the entries to move through the history. You can purge the history list from Edit > Purge History.

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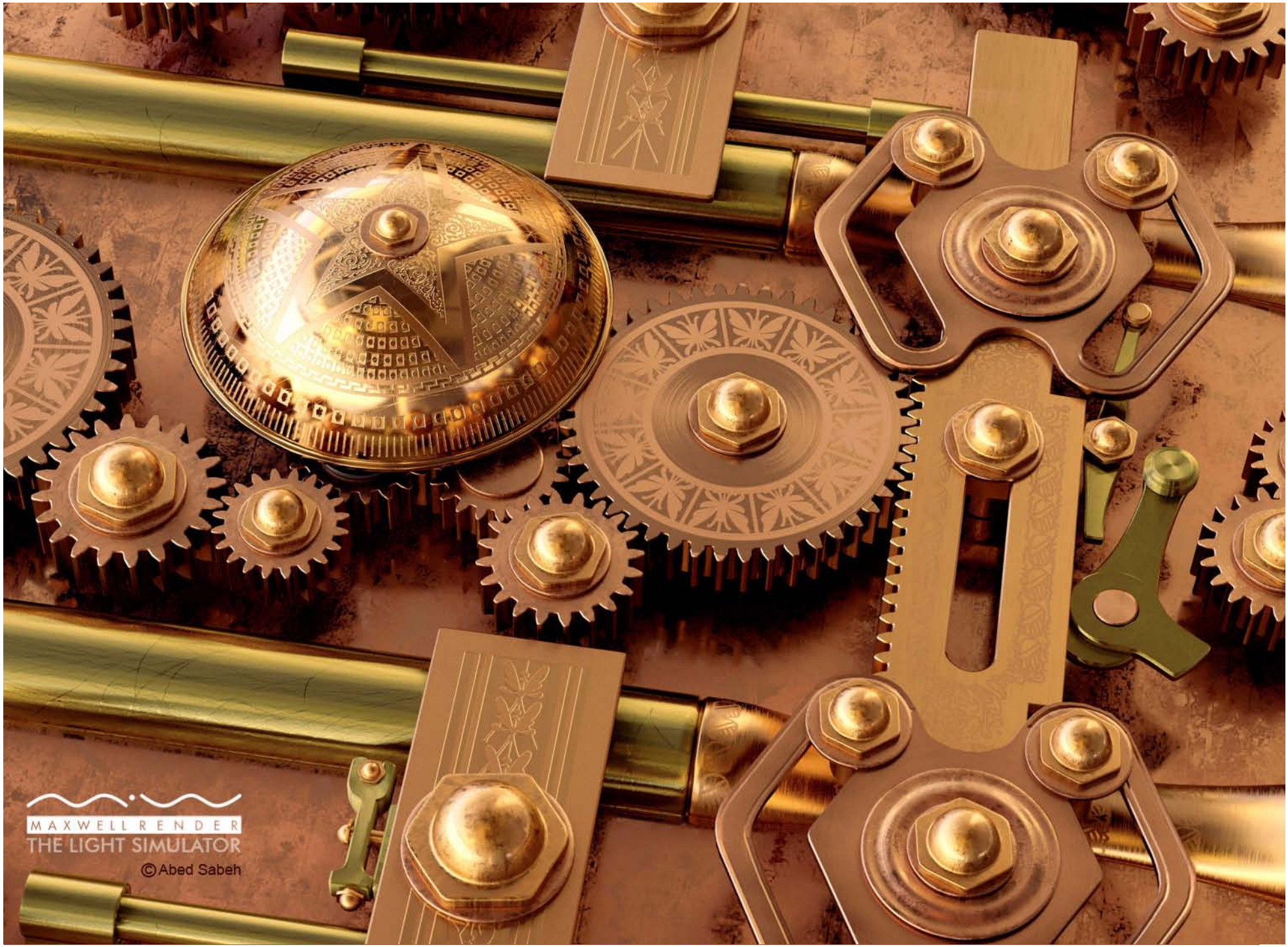

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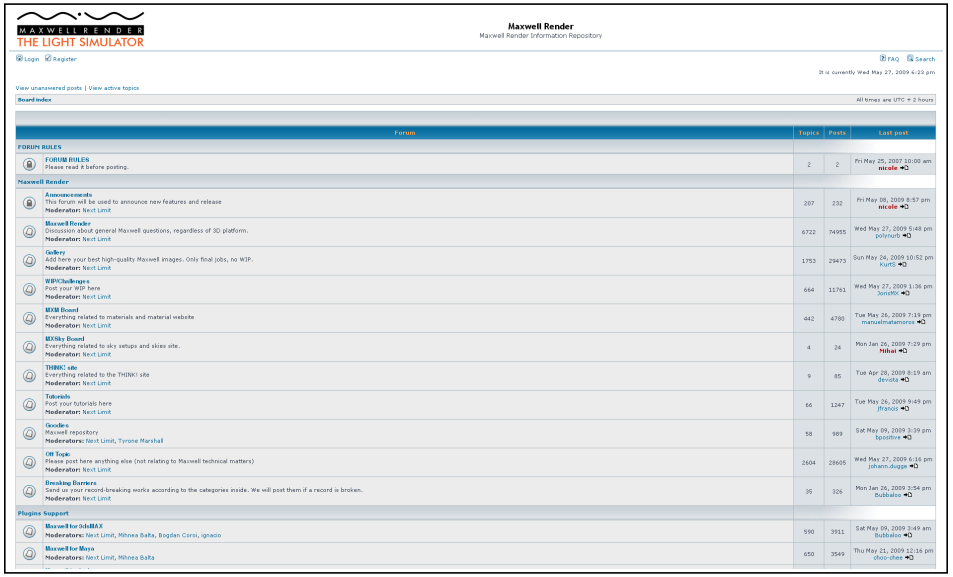
13 MISCELLANEOUS

13.01 Community and Learning

Maxwell Render™ Forum
One of the most active and useful learning resources available for Maxwell Render is made up of the users themselves: the Maxwell Render™ forum.



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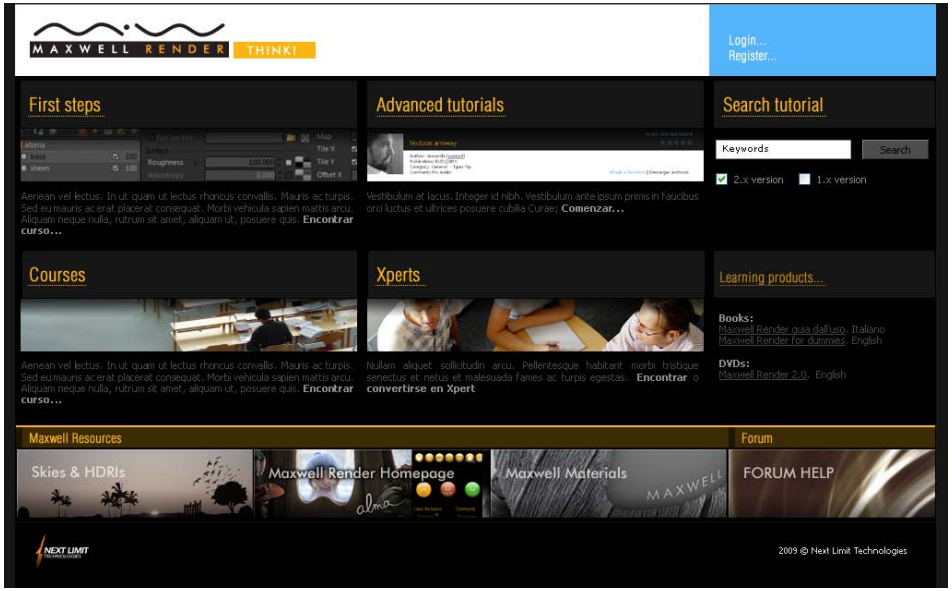
If you have a question, a problem, need advice or are looking for comments on your renders, the Maxwell Render forum is the place to be. License holders can get VIP status to obtain full access to the forum and be able to write posts. They just need to register in the forum. Demo users can read the forum and do searches, but they won't be able to write posts.

http://www.maxwellrender.com/forum

THINK!

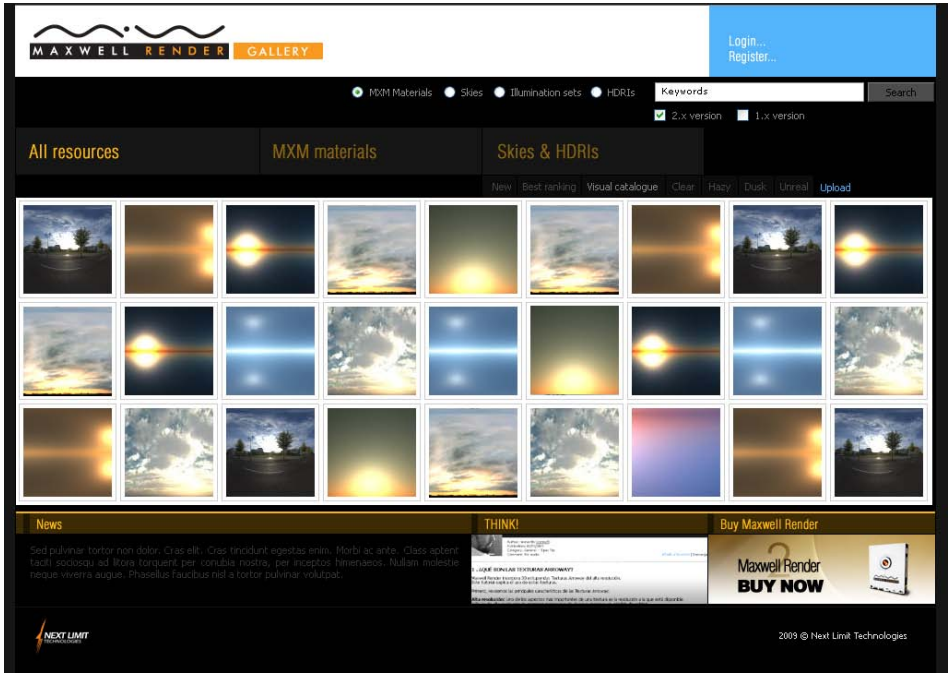
This website has been created for Maxwell Render users to share their knowledge with others. THINK! offers tutorials, tips, videos, scene files, and documents and some materials have been translated to other languages. You can also search for courses or Maxwell Xperts in your area. If you are looking for a tutorial or other learning resources then just visit the THINK! website.



http://think.maxwellrender.com/

Maxwell Render Resources – the Maxwell material repository

The Maxwell Resources site, which incorporates the MXM gallery, offers thousands of free materials, skies and is an invaluable source of materials for your Maxwell scenes. It is also a great learning resource - just download a material and see how it was made. Maxwell Render users from all over the world upload new materials every day, and you are welcome to take part too.



http://resources.maxwellrender.com

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13.02 Optimization methods and Tips

There are several things you can do to optimize a scene, mostly related to emitters:

- Make sure your emitting surfaces are as low-polygon as possible. Usually, a single-sided polygon will be sufficient.
- If possible, do not completely enclose your emitters inside a dielectric object. All light that is emitted through the dielectric object is considered caustic light and will take longer to render.
- Make sure your emitter is not intersecting other geometry. In most cases this will not be a problem but it may add to the render time and produce strange results in the lighting. Regular geometry can intersect other geometry.

  ☑ *Very important: Do not use very white or fully saturated materials in your scene. For example, a completely white (255, 255, 255) material will take a very long time to clear and will also make the contrast in the image disappear. Also avoid completely saturated colors such as pure red (255, 0, 0). Pure white or pure saturated materials do not exist in real life so it is better to decrease the saturation a bit. For a white wall, around RGB 220, 220, 220, which is the albedo of white paper, is sufficient.*

- For interior renders where window glass reflections are necessary, use the AGS glass material for the windows instead of real glass. This will create the reflections but will not produce caustics, thus speeding up the rendering.
- Perhaps you simply need more time for rendering, depending on your machine specs. Check www.benchwell.com to know how fast your machine is.

13.03 SDK

The Maxwell Render Software Development Kit is included in the Maxwell Render software. The SDK is available for Mac OSX, Win 32, Win 64 and Linux 64. If you are a developer and are interested in the Maxwell Render SDK then please download (the demo version of) Maxwell Render: the SDK is included in the installer. Please make sure to read the SDK Agreement before starting to work with the SDK. We would of course be happy to hear about your work and developments, and we are available to answer any queries you may have. Please contact us at http://www.nextlimit.com/contact_sales.php

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14 APPENDIX I. MATERIAL EXAMPLES

This guide will assist you to create basic materials and offers tips to help you better understand the parameters discussed in the manual. We strongly encourage you to experiment with the material system, starting with simple one-BSDF materials

a. Example 1: Concrete. Diffuse materials

Fig.01 concrete1 by hortenIX

Fig.02 Seamless arrows floor by artaud

Diffuse materials like concrete are characterized by their high roughness. Typical diffuse materials like walls, paper, and concrete have a roughness near 100%. A value of 100% represents a fully diffuse material (also called Lambertian). This is the simplest type of material.

Set your material's roughness to 100% to create a completely diffuse surface.
Use an image of concrete for the Refl 0º. The Refl 90º color is not important here because we are using a high roughness value.

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Use a bump map to add bumps to the surface. Check the Normal map icon if you prefer to use a Normal map.

More concrete examples at the MXM Gallery...

b. Example 2: Plastic

Fig.01 fiberglass by rivoli

Fig.02 Blue _ Dull Plastic by DarkSonofChronos

A plastic material can be created using a two-BSDF material. The first BSDF is the plastic's base color. Set the Refl 0° color to the color of your plastic. The Refl 90° and Nd numbers do not matter and can be left at default because we are using a high roughness value to create a 100% diffuse material. So set roughness to 100%.

The second BSDF is the shiny "topcoat" of the plastic. The Refl 0° color can be left at default or you can raise it or lower it to have an overall shinier or duller plastic. The Refl 90° color can also be left at default because we want the plastic to be very shiny at the edges, and we do not want any tinting of the reflections.
Nd should be set to 3 which is a good value for plastics.
The blending weight of the second BSDF was set to 30 so that the shiny BSDF has less influence on the final material. This will create a more realistic plastic.

To make the plastic more or less shiny, there are two possible approaches:

1. You can lower the Refl 90° color, and/ or lower the Nd of the second BSDF to make it less shiny. Conversely, you can raise the Nd to make the plastic shinier, given that the Refl 90º is already set to the maximum value.
2. You can increase the blending weight of the second BSDF so it will have more influence on the final look of the material.

You can also create a plastic using Additive mode, creating two layers with one BSDF each. Set the top layer (the shiny top coating) to Additive, and adjust the layer's weight to make it more/ less shiny. This approach will create more vivid-looking plastics which may be preferable in certain cases.

Avoid having more than one layer set to a weight of 100 in Additive mode. A material with three layers, two of which are set to Additive and have a weight of 100, will look unrealistically reflective. And it will also add to the render time. This does not apply to layers in Normal mode.

More plastic examples at the MXM Gallery

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c. Example 3: Shiny wooden floor

The set-up for the plastic material can be copied almost entirely for this particular material. We only need to add a diffuse texture to the first BSDF, and a bump map.
The diffuse texture should be added to the first BSDF in the Refl 0° slot. The bump map should also be added to this BSDF with a strength set to two. Experiment with the bump value and remember that the bump parameter is quite sensitive. Very high values (such as 100) can produce unrealistic effects and longer render times.

The second BSDF can be left untouched. You could just increase the roughness value to avoid perfectly smooth reflections. For the image below the roughness was set to 15. If the floor is too reflective, the quickest way to change the amount of reflection is to lower the weight value of this BSDF.

Fig.01 Burnished Lacquered Bubinga by JDHill

Fig.02 Black Ash by stekanio

More wood examples at the MXM Gallery

d. Example 4: Mirror

A completely reflective surface can be created using a single BSDF layer. Set the Refl 90° of your material to pure white. Adjust the roughness parameter to a very low value like 0. You can increase the value (to for example 20) if you would like to create a glossier mirror. Set the Nd high enough (to 30 for example) to make sure the object is equally reflective from all viewing angles.
Check the Force Fresnel option to make sure the reflectance of the object is only affected by the Nd and not by the Refl 0° color. More information about the Force Fresnel option can be found in Chapter 10 in the BSDF Properties section.

Fig.01 nickel plating by tom_nextlimit

Fig.02 smoke n-mirrors by abeezley

More mirror examples at the MXM Gallery

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e. Example 5: Common glass

To create a common glass material, the Refl 90° color can be left at 255 because this glass will not tint the specular reflections. In addition it will reflect almost light at this viewing angle.

Set the Transmittance color to the color you want the glass to be (255, 255, 255 for pure white glass, or 227, 230, 230 if you want to give it a slight green/ blue tint). Transmittance is set a little low to mimic a low-grade glass with imperfections that give it more color: it is not completely transparent like high-grade optical glass types.

Fig.01 Low grade glass by Mihaii

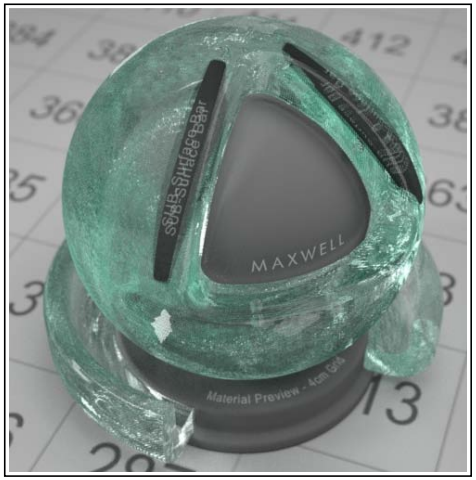

Fig. 02 subtle Sandblasted glass by jomaga

Set the Attenuation distance to 3 cm which is a good value to use for common low-grade glass. Remember from the material section that Attenuation distance is the distance the light travels through a material before losing half its energy. This means that for a glass panel of 1.5 cm thickness, the light passing through it and reaching the other side will have lost a quarter of its strength. For high-grade glass the Attenuation distance can be much larger – even more than five meters – because it has a lot less impurities which attenuate the light.
Setting a higher Attenuation distance means you will get clearer glass so that it will be easier for light to pass through it.

Set the Nd to 1.51 which is a reasonable Nd for glass. Following the relationship between Nd and the Fresnel effect, we can use the Fresnel formulas to calculate that the reflectance of this material (with an Nd of 1.51) near incidence angle (looking straight on at the material) would be about 4%, which translates into a RGB around 11. This is the value you should use for the Refl 0° color. Of course you do not normally have to calculate this value exactly; just know that for materials with an Nd around 1.5, the Refl 0° color has a value of around 10-20. You can raise it if you want shinier looking glass. If you want to create a very realistic glass, you should look at (images of) real glass objects for references. Most glass materials have an Nd around 1.5.

Remember that Attenuation distance and Transmittance are parameters that work together. For example, you can set a low Transmittance value (such as 220, 210, 200) and start with an Attenuation distance of 3 cm to create a heavily-tinted glass. Raising the Attenuation distance will make the glass clearer. If instead you raise the Transmittance value but leave Attenuation distance at 3 cm, the glass will become less color-tinted but will still be relatively dark.

Roughness must be set to 0 for a perfectly smooth glass. Increase this value (for example to 20) if you want to get a glossy "frosty" glass.

More glass examples at the MXM Gallery

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f. Example 6: Clipmaps using layer mask

Clipmaps are easy to create. Use the layer mask image to make an object visible in some parts and invisible in others. Clipmaps are useful for leaves, decals, perforations in objects, and even to simulate objects using a single-textured plane (people, vegetation, etc).

Fig.01 Grass by thxraph

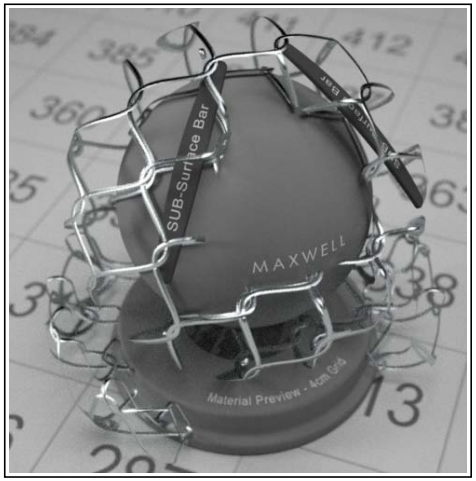

Fig.02 Wire mesh by F_Tella

First, create a material as usual (reflectance, transmittance, Nd, roughness, etc). Then load the clipmap to the layer weight texture slot. White areas show the material as it is and darker areas make the layer vanish slightly. Pure black areas will make the layer completely invisible, allowing you to see the layers underneath.
If there is only one layer in the material, the black areas of the clipmap will make the object invisible.

More clipmap material examples at the MXM Gallery

g. Example 7: Multi-layered material

Maxwell Render's stacked layers system allows you to create complex and very sophisticated materials. Each layer corresponds to a specific material, so each layer can contain several BSDFs blended together, coatings, SSS, etc. Think of a layer as a complete material on its own, with its own displacement, BSDFs, and coatings.

Fig.01 Rusty Chrome Metal by Miguel

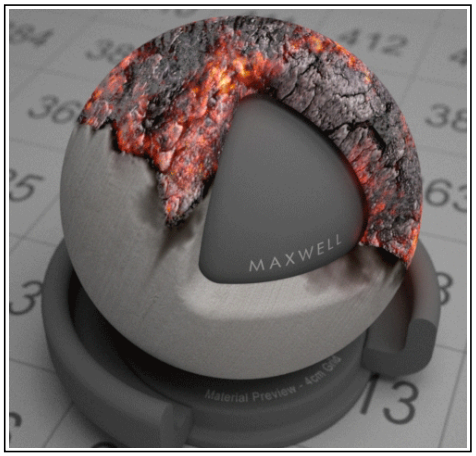

Fig.02 Cigarette Break by rusteberg

To create a partially rusty metal sheet, begin by creating the rust layer. Apply a Refl 0º map and a bumpmap. Roughness should be a high value (for example 100). Name this layer "rust".
Now create a new layer over the first. Name it "paint". You can use the Wizard to quickly apply a car paint material. Or combine two or three BSDFs to copy the look of a clean, newly-painted metal sheet. Adjust the weight value of the "paint" layer to mix it with the "rust" layer underneath, or better, use a grayscale map as a mask to remove the "paint" layer from certain areas, allowing for the rust to peep through.
You can also load a global bump/ normal map that will be applied to the whole material from the Material Properties row in the Layers list. Each layer can have one displacement component but only one of the displacement components will be used for rendering. You can specify which one you wish to use for rendering in the Material Properties panel.

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15 APPENDIX II. PROGRESSIVE RENDERING WORKFLOW

"Maxwell Render has a really good feature that lets you continue to render a sequence after you have stopped it once. For example, depending on the scene, let's say that Maxwell Render needs to achieve 20 sampling levels before the image is completely free of grain. Again, as an example, this takes three hours to achieve. To render them up to the first 12 sampling levels (SL), though, only takes a few minutes, as every sampling level approximately doubles the render time. At SL 12, even though it's a bit grainy, we can clearly check that it looks how we want without any bugs, collisions of geometry, etc. Once approved, we then take those images into comp and start doing the post work needed. At the same time, we send the SL 12 images to the render farm and continue rendering them up to the final SL level.

Before we always had to wait for the rendered frames to be finished before going into comp.

This way it feels really nice to be finished before the rendering is done."

Michael Bengtsson, CEO/VFX supervisor at Meinbender Animation Studio

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15.01 The Progressive rendering script

Maxwell Render now includes some interesting utilities that can improve your workflow allowing you to overlap the rendering and postproduction processes so they take place simultaneously.

These utilities are based on the principle of resuming a low Sampling Level render to get a cleaner image while you can start your post-production process with that quick low SL image or sequence, and Maxwell keeps cleaning up your render during your post-production time. Finally you can replace the low SL image or sequence with the final SL one at the end of the process.

With Maxwell Render there is no need to use the classic un-efficient workflow: rendering a quick proxy version of the sequence before post-production, and re-launching that proxy at final resolution from the start again. This doubles the process, and wastes a lot of rendering time.

With Maxwell Render, the rendering process and the post-production process really overlap each other, running almost parallel rather than the classic serial approach, making the render time almost disappear as it runs silently in the background during post-production time.

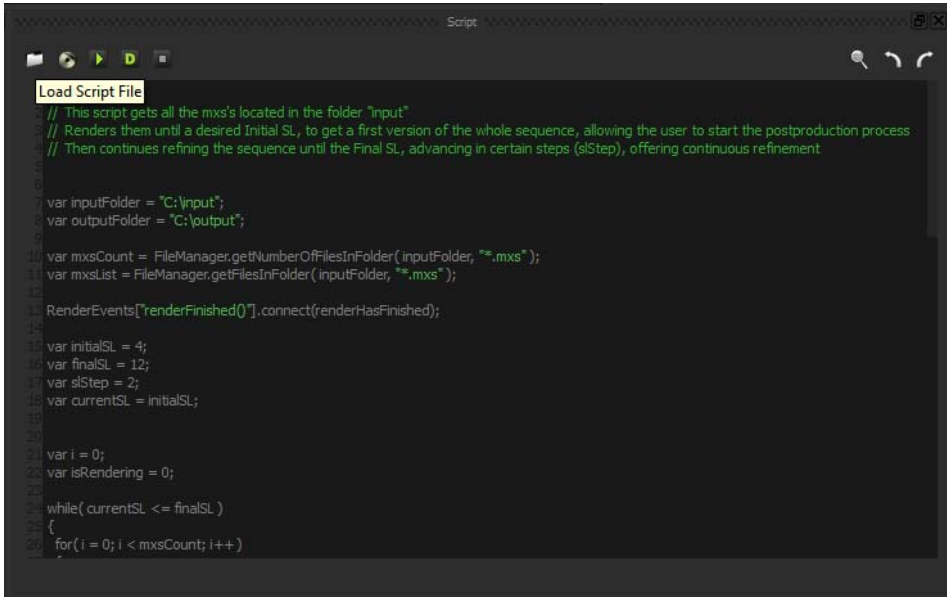
This ultra-efficient workflow can be used for both animation sequences and still images.

One of the utilities that allow this efficient parallel workflow is the "progressive_animation" script, that you can load from the Load Script File button in Maxwell Render.

This script renders all the MXS scene files located in the indicated "input" folder, starts rendering them all up to an initial Sampling Level value, and stores the resulting images in the "output" folder (you may also need to set the resolution and output image format below in the script code).

At this moment you will have a quick full resolution version of the whole sequence or individual renders, that allows you to start the compositing and postproduction process. After that, the script automatically starts resuming all the renders from that initial SL in certain SL steps, until the whole sequence reaches the final SL you indicated.

This way you get a continuously refining sequence that you can start compositing while simultaneously the whole sequence gets progressively cleaned up during your post-production time, saving you a lot of time.


Script
Load Script File
// This script gets all the mxs's located in the folder "input"
// Renders them until a desired Initial SL, to get a first version of the whole sequence, allowing the user to start the postproduction process
// Then continues refining the sequence until the Final SL, advancing in certain steps (slStep), offering continuous refinement
var inputFolder = "C:\input";
var outputFolder = "C:\output";
var mxsCount = FileManager.getNumberOfFilesInFolder(inputFolder, "*.mxs");
var mxsList = FileManager.getFilesInFolder(inputFolder, "*.mxs");
RenderEvents["renderFinished()"].connect(renderHasFinished);
var initialSL = 4;
var finalSL = 12;
var slStep = 2;
var currentSL = initialSL;
var i = 0;
var isRendering = 0;
while(currentSL <= finalSL)
{
for(i = 0; i < mxsCount; i++)
Progressive rendering

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15.02 Progressive rendering on the Network

You can also use this progressive approach to render your animation sequences on the Network System.

To create a progressive rendering animation job, you simply have to add an Animation Job with the Network Wizard, setting the SL to the initial Sampling Level you want (let's say SL=10), and launch that job to the network.

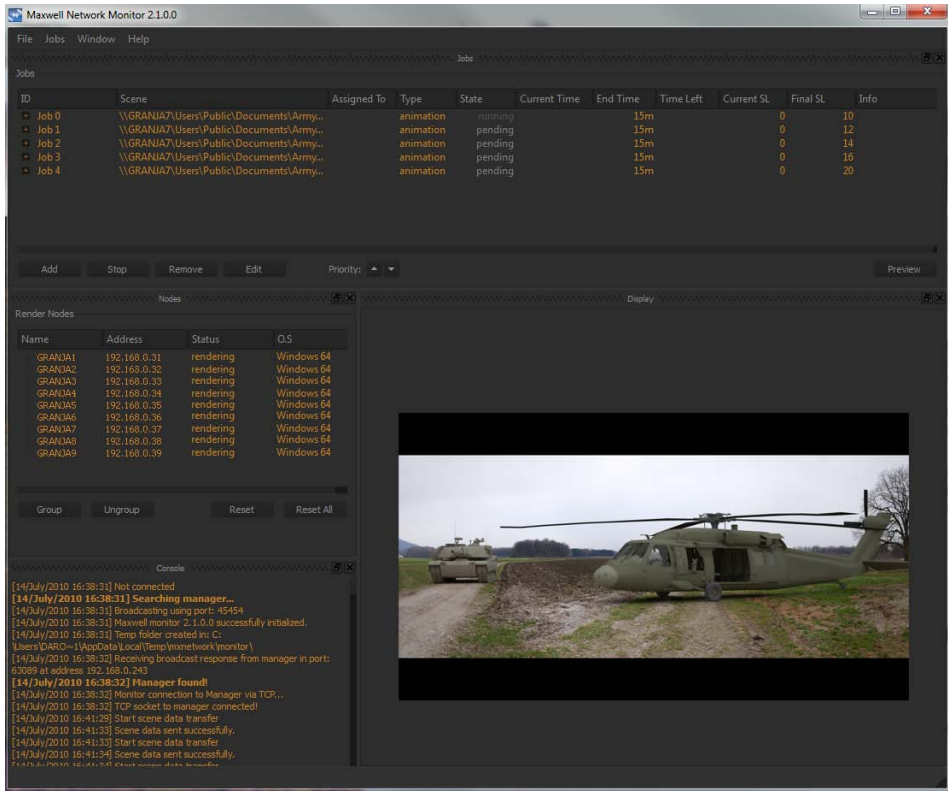
Once the first frame in the sequence reaches SL=1, you can add another Animation Job for this same sequence and same settings, but with a further Sampling Level (let's say SL=12). As the Wizard detects that there is almost one rendered MXI from that job (because you've waited until the first frame reached SL=1 and the first MXI is stored in the output location), it is detected as a resume job, and this second job will resume the initial sequence from the initial Sampling Level (in this example SL=10) to the next one.

Add another job for resuming it to, let's say, SL=14 and another for SL=16 (you don't have to wait here anymore, as all the jobs will be detected as resume jobs due the first MXI that it is detecting).

This way you can create a queue of jobs over the same sequence, that will produce a low Sampling Level version of the whole sequence (let's say at SL=10) in a few minutes to start the post-production with, and then the sequence will be resumed to a further SL (in this example to SL=12), after that resumed again to SL=14 and SL=16, providing a continuous improvement in the whole sequence while you are already working on the post-production process, and getting a continuous progressive improvement as the render keeps working on.

As the render refinement happens simultaneously while you are post-producing with the initial SL version, the render time almost disappears, being overlapped during your post-production process, and creating an ultra-efficient unprecedented workflow.

This way you get a continuously refining sequence that you can start compositing while simultaneously the whole sequence gets progressively cleaned up during your post-production time, saving you a lot of time.


Maxwell Network Monitor 2.1.0.0
File Jobs Window Help
Jobs
ID Scene Assigned To Type State Current Time End Time Time Left Current SL Final SL Info
Job 0 \\GRANJA7\Users\Public\Documents\Army... animation running 15m 0 10
Job 1 \\GRANJA7\Users\Public\Documents\Army... animation pending 15m 0 12
Job 2 \\GRANJA7\Users\Public\Documents\Army... animation pending 15m 0 14
Job 3 \\GRANJA7\Users\Public\Documents\Army... animation pending 15m 0 16
Job 4 \\GRANJA7\Users\Public\Documents\Army... animation pending 15m 0 20
Add Stop Remove Edit Priority: Preview
Render Nodes
Name Address Status O.S
GRANJA1 192.168.0.31 rendering Windows 64
GRANJA2 192.168.0.32 rendering Windows 64
GRANJA3 192.168.0.33 rendering Windows 64
GRANJA4 192.168.0.34 rendering Windows 64
GRANJA5 192.168.0.35 rendering Windows 64
GRANJA6 192.168.0.36 rendering Windows 64
GRANJA7 192.168.0.37 rendering Windows 64
GRANJA8 192.168.0.38 rendering Windows 64
GRANJA9 192.168.0.39 rendering Windows 64
Group Ungroup Reset Reset All
Console
[14/July/2010 16:38:31] Not connected
[14/July/2010 16:38:31] Searching manager...
[14/July/2010 16:38:31] Broadcasting using port: 45454
[14/July/2010 16:38:31] Maxwell monitor 2.1.0.0 successfully initialized.
[14/July/2010 16:38:31] Temp folder created in: C:\Users\DARO~1\AppData\Local\Temp\mxnetwork\monitor\
[14/July/2010 16:38:32] Receiving broadcast response from manager in port: 63089 at address 192.168.0.243
[14/July/2010 16:38:32] Manager found!
[14/July/2010 16:38:32] Monitor connection to Manager via TCP...
[14/July/2010 16:38:32] TCP socket to manager connected!
[14/July/2010 16:41:29] Start scene data transfer
[14/July/2010 16:41:33] Scene data sent successfully.
[14/July/2010 16:41:33] Start scene data transfer
[14/July/2010 16:41:34] Scene data sent successfully.
Progressive rendering on the Network

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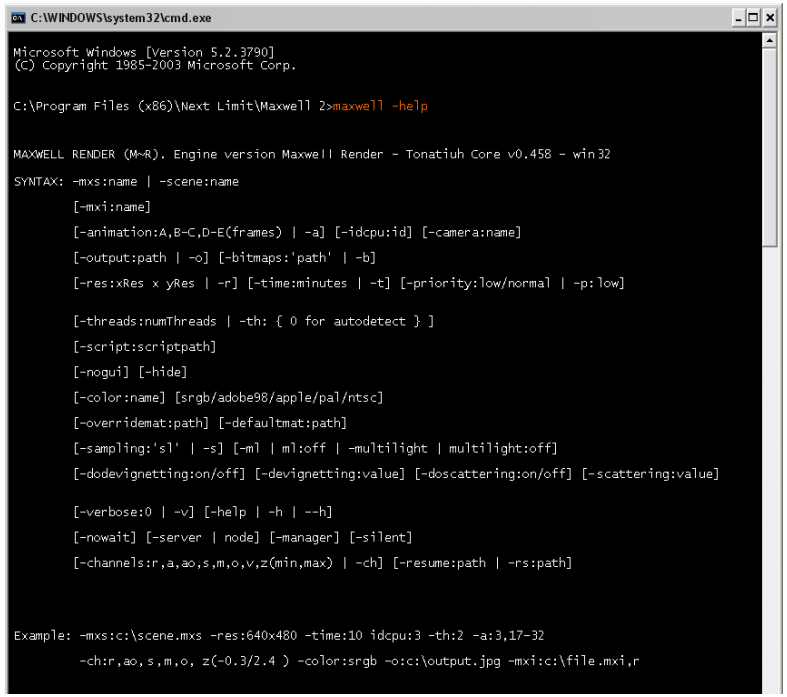
16 APPENDIX III. COMMAND LINE COMMANDS AND EXIT CODES


C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.
C:\Program Files (x86)\Next Limit\Maxwell 2>maxwell -help
MAXWELL RENDER (M~R). Engine version Maxwell Render - Tonatiuh Core v0.458 - win32
SYNTAX: -mxs:name | -scene:name
[-mxi:name]
[-animation:A,B-C,D-E(frames) | -a] [-idcpu:id] [-camera:name]
[-output:path | -o] [-bitmaps:'path' | -b]
[-res:xRes x yRes | -r] [-time:minutes | -t] [-priority:low/normal | -p:low]
[-threads:numThreads | -th: { 0 for autodetect }]
[-script:scriptpath]
[-nogui] [-hide]
[-color:name] [srgb/adobe98/apple/pal/ntsc]
[-overridemat:path] [-defaultmat:path]
[-sampling:'sl' | -s] [-ml | ml:off | -multilight | multilight:off]
[-dodevignetting:on/off] [-devignetting:value] [-doscattering:on/off] [-scattering:value]
[-verbose:0 | -v] [-help | -h | --h]
[-nowait] [-server | node] [-manager] [-silent]
[-channels:r,a,ao,s,m,o,v,z(min,max) | -ch] [-resume:path | -rs:path]
Example: -mxs:c:\scene.mxs -res:640x480 -time:10 idcpu:3 -th:2 -a:3,17-32
-ch:r,ao,s,m,o, z(-0.3/2.4) -color:srgb -o:c:\output.jpg -mxi:c:\file.mxi,r

F.01 Command line screenshot

The core rendering application can be launched either from the command line, from Studio or from the Maxwell Render plug-in from your 3D application.
The rendering process can be also controlled using certain command line commands.

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To launch Maxwell Render via the command line, type "maxwell" in a command line window.

Maxwell commands should be listed as shown in the image below (Windows OS).

Running Flags	Description
-curdir:path	Set the current directory of the OS. This could be useful for using relative paths for textures and other dependencies.
-display **-d**	Open a window that displays the render in progress. This option is also used when distributing render tasks (display is on by default).
-help **--help** **-h** **--h**	Help (print syntax).
-hide	No display and No console view (process completely hidden).
-nogui **-n**	Console view on. Display off.
-node	Launch Maxwell Render in no GUI node mode and using a node license.
-nowait	Close the rendering application after the render finishes and returns control to the console.
-priority **-p** **[low | normal | high]**	Set the priority of the Maxwell process. It can be "low", "normal" or "high".
-verbose **-v:**	Verbosity level (0: no information given, 1: errors, 2: warnings, 3: info, 4: all, debug: debug level).

Parameters	Description
-alphaopaque: **[on | off]**	Enable/disable the opaque mode in alpha channel.
-animation: **-a:**	Specify a sequence of frames to render. This can be provided in the form of individual frames separated by a semicolon (3;5;7) or a range in the form A-B (from frame A to frame B), or a combination of both.
-dependencies:path **-dep:path** **-bitmaps:path** * **-b:path** *	Set an alternative folder path for the dependencies location. ☑ *Note: These commands are kept for ensuring compatibility with older versions, but we advise the use of "-dependencies" or "-dep" for refering to more generic concepts.*
-burn:value	Set the burn value.
-camera:name	Specify the name of the camera you want to render from in case it does not match with the active camera in your MXS scene file.

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Parameters	Description
-channel: [channel_name], [yes|on|no|off], [depth (8,16,32)], [format]	This option establishes the different channels that Maxwell Render™ can export and their format. All the parameters are optional except the first one. *Example:* *-channel:alpha,on,32,tif --> will render the alpha channel in tif 32 format* *-channel:material -->will render the material id channel* *-channel:object,off --> will disable the object id channel if it was enabled in the scene* Other flags added are: -zMin:value --> set the zmin value of the zbuffer channel -zMax:value --> set the zmax value of the zBuffer channel -alphaopaque --> Enable alpha opaque -alphaembeded --> Enable alpha embedded -embedded --> Embeds the selected channel when the output format allows it.
-channelsembedded: [on | off]	Enable embedding all the channels as image layers if the format supports it.
-color:	Set a color space.
-defaultmat: [on | off]	Enable/disable the default material.
-defaultmat: path	Indicate the path to the default material.
-depth: [8 | 16 | 32]	Adjust the depth in bits of the image output. It can be 8, 16, or 32. Take into account that the depth will be affected by the format; for instance if you type -depth:32 and the output is in JPG that does not support 32 bits the depth will be adjusted automatically.
-devignetting:value	Values range from 0 to 100 for the suppression of the vignetting effect on the image borders

Parameters	Description
-dispersion: [yes|on|no|off]	Enable/disable the dispersion calculations for the whole scene
-displacement: [yes|on|no|off]	Enable/disable the displacement calculations for the whole scene.
-dodevignetting:on/off	Enable/disable the suppression of the vignetting effect
-doscattering:on/off	Enable the lens scattering for the render
-extractlights:	Save each light in a separate file if Multilight is enabled.
-gamma:value	Set the gamma value.
-idcpu:	By default the render is initialized to a random value when the rendering starts. It is useful for rendering the same MXS file on different computers that are not networked together.The resulting MXI files of each render can be copied manually to the same computer and merged in Maxwell using File> Merge MXI. Each resulting MXI must have a different starting seed for the noise pattern to be slightly different in each MXI, otherwise the merging of MXI files will not work correctly. The user does not have to set this parameter unless they want to render with the same idcpu on all computers, in which case all the MXI files will have the exact same noise pattern.
-mintime:	Set the time to impose a minimum time for saving MXI files to disk. It works like the new preference "Min.Time for saving to disk
-motionblur: [yes|on|no|off]	Enable/disable the motion blur calculations for the whole scene.
-multilight -ml [off | intensity | color]	Set the Multilight mode. Values are "off", "intensity" or "color".

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Parameters	Description
-mxi:path	When rendering, Maxwell writes a special MXI file that contains information about the rendering process. This file allows the user to resume a previously rendered image. If this command is not used, the MXI will use the same name and path as the MXS scene.
-mxs:path **-scene:path**	Specify the full path and name of the scene file to render (in MXS format).
-nomxi:	Force Maxwell Render not to save an MXI file but just the output image file.
-output:path **-o:**	Specify the full path and name of the image file. By default, Maxwell saves a file "default.tga" in the output folder of the installation path. The file name can refer to any of the multiple graphic formats supported (tga, jpg, tif, png, exr, etc). In case of sequences, the output files will be numbered with a four digit suffix.
-overridemat: **[on | off]**	Enable/disable the override material.
-overridemat:path	Override all materials in the scene using the material indicated in the path.
-pass:	Set the render pass. It can be "diff+refl" (the default), "diff" (diffuse pass) or "refl" (reflections pass).
-region: **type,x1,y1,x2,y2 :**	Specify if you want to render the full frame, a region, or blowup a region, specifying also the coordinates of the rectangular marquee. Type is "full", "region" or "blowup"
-renameoutput :	When this flag is used Maxwell Render does not write the MXI file directly in the given output path; it writes a temporary file and when the writing process finishes it renames it to the final path.This can be used by 3rd part job managers to ensure the MXI file is not being written when they try to access it.

Parameters	Description
-res: WxH **-r: WxH**	Specify the resolution of the render in pixels (W=width, H=height).
-resume:path **-re:path**	Continue a render from a previously saved MXI file. To resume a previously rendered image and update the MXI file, this flag must be added. Note: The MXI file is useful to resume the rendering process later, to use Multilight™ (when the Multilight™ option has been enabled) or to use it as a light emission map.
-sampling: **-sl:**	This value establishes a quality level for the render. This value is useful when you want to render a sequence of frames using different hardware configurations. If the quality level is reached before the "maximum render time", then the render ends. Alternatively, if the maximum render time is reached before the sampling level, the render also stops the calculus. To get an idea of the image quality during the render process, you can take a look at the command line window, where the sampling level is continually updated.
-scattering:value	Values range from 0 to 100.
-script:path	Load and run a given script.
-slupdate: [seconds]	Force the engine to refresh the sampling level info at the given ratio instead of doing it automatically. It can be useful when launching renders from external process to query info about the render progress.
-time: **-t:**	Specify the time (in minutes) that Maxwell Render is allowed to use to render every frame. Maxwell Render can render the scene in a specified amount of minutes, providing the best possible quality.

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Parameters	Description
-threads: **-th:**	Specify the number of threads (N) that Maxwell Render is allowed to use. Normally this should be equal to the number of CPUs available in the system. By default, N is the number of CPU s found in the system except in cases where hyper threading features are available. ☑ *Note: When N is 0 (-th:0), Maxwell Render™ uses the maximum number of CPU available.*
-zmin:value	Set the minimum value for the zbuffer channel in meters.
-zmax:value	Set the maximum value for the zbuffer channel in meters.

Flags in MXED	Description
-browser	Launch MXED in browser mode.
-brwclose	Launch MXED in browser mode and close it after selecting a MXM file. The selected MXM file is printed in console.
-close	Close MXED after executing all the instructions given for the rest of the parameters.
-closewz	Close MXED when the wizard is closed if it has been launched.
-ed	Launch MXED in editor mode.
-force	Force the preview after loading the material.
-hideconsole	Hide the OS console. Windows only.
-mxm:[path]	Load an MXM file with the given [path].
-mxmgallery:[path]	Launch the MXM gallery search dialog and download the selected material in [path].
-mxsprv:[path]	Set the MXS file located in [path] as the active preview scene.
-new:[path]	Create a new material and save it in the given [path].
-same	Don't open another instance of MXED but use the one already opened.
-wizard	Launch the material wizard.

These are the error codes that Maxwell Render returns through the command line.

Exit Codes	Description
0	Render succesfull
1	Critical error

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17 APPENDIX IV. SCRIPTING REFERENCES

17.01 Introduction

Maxwell Render provides basic scripting capabilities that allow you to make simple scripts and macros to automate common tasks such as launching render batches, converting several MXIs at the same time, etc. All the parameters of the Maxwell Render UI are accessible through scripts. The Maxwell Render scripting engine is based on ECMA standards (like other popular scripting languages such as Javascript and Actionscript), and provides default compatibility with these standards. The script editor in Maxwell Render also contains a debugger which provides basic debugging tools common in development environments. See the "Script Tab" text for more information about scripting and how it works.

For more information about ECMA visit:

- http://www.ecmascript.org/
- http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-262.pdf

This document assumes the user has basic knowledge of scripting and programming.

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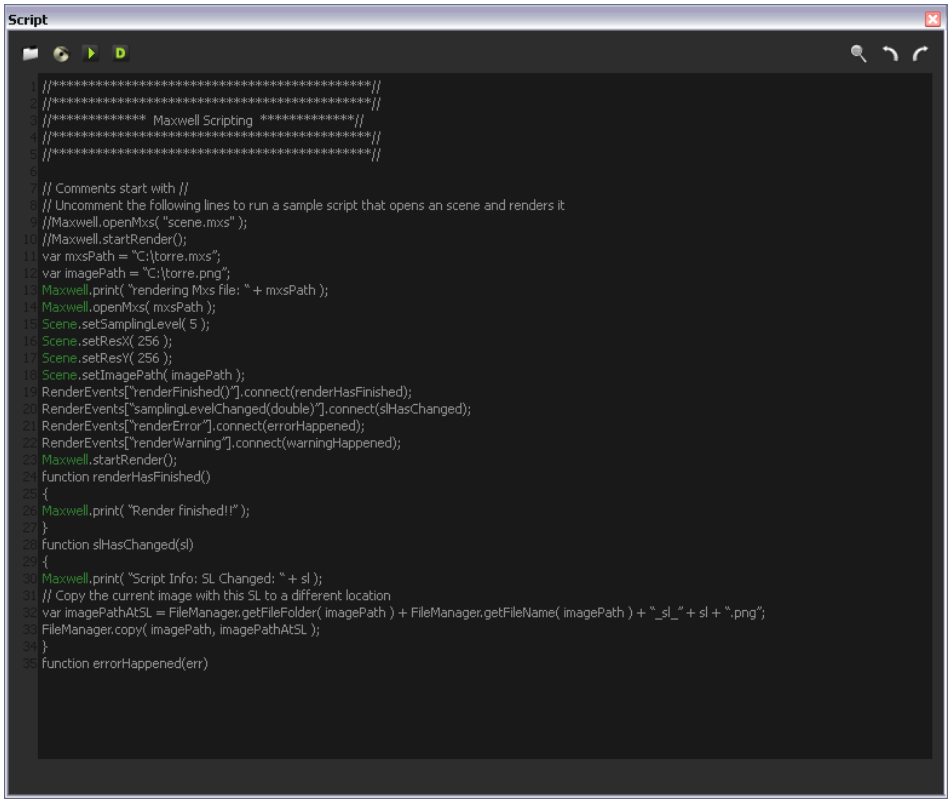

F.01 Scripting window

17.02 References

17.02.01 Maxwell Object

- **Function:** void openImage(string path);
- **Description:** Loads an image to the Maxwell Render GUI.
- **Parameters:** path: Path of the image. Read the relevant section of the manual for a full description of supported image formats.
- **Returned Value:** Nothing.

- **Function:** void openMxi(string path);
- **Description:** Loads an MXI file to the Maxwell Render GUI and displays its parameters in the UI.
- **Parameters:** path: Path of the MXI file.
- **Returned Value:** Nothing.

- **Function:** void openMxs(string path);
- **Description:** Loads an MXS file to the Maxwell Render GUI and displays its parameters in the UI.
- **Parameters:** path: Path of the MXS file.
- **Returned Value:** Nothing.

- **Function:** void saveImage(string path);
- **Description:** Saves the current image buffer displayed in the GUI in the given image file.
- **Parameters:** path: Path of the image file.
- **Returned Value:** Nothing.

- **Function:** int launchProcessAndWait (string execPath, array arguments);
- **Description:** Launches an external process with the given path and arguments and waits until it finishes.
- **Parameters:**
  -string execPath: Absolute path of the executable.
  -array arguments: list of command line arguments.
- **Returned INT:** 0 if the process finished successfully and 1 if the process crashed.

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- **Function:** int launchProcess (string execPath, array arguments);
- **Description:** Launches a detached process and returns the control immediately, without waiting for the process to finish.
- **Parameters:** -string execPath: Absolute path of the executable. -array arguments: list of command line arguments.
- **Returned INT:** 0 if the process was started successfully and 1 if not.

- **Function:** bool saveLog (string path);
- **Description:** Saves the console log to the given path.
- **Parameters:** string path: path of the saved log .
- **Returned Value:** Bool: TRUE if the log is properly saved. FALSE if not.

- **Function:** void clearConsole ();
- **Description:** Clears the console
- **Parameters:** Nothing.
- **Returned Value:** Nothing.

- **Function:** void printError (string message);
- **Description:** Prints an error message in the console.
- **Parameters:** string message: message to print.
- **Returned Value:** Nothing.

- **Function:** string getOS ();
- **Description:** Returns the operating system currently used.
- **Parameters:** Nothing.
- **Returned Value:** String: OS.

- **Function:** void saveMxi(string path);
- **Description:** Saves the current image buffer displayed in the GUI in the given MXI path.
- **Parameters:** path: Path of the MXI file.
- **Returned Value:** Nothing.

- **Function:** void saveChannel(int channelIndex, string path, int depth);
- **Description:** Saves the channel with the given index to disk.
- **Parameters:** int channelIndex: Index of the channel / path: Path were the channel will be saved. int depth: bits depth of the saved channel (depths supported are 8, 16 and 32)
  Channels indexes are:
  CHANNEL_RENDER = 0,
  CHANNEL_ALPHA = 1,
  CHANNEL_SHADOW = 2,
  CHANNEL_ID_MATERIAL = 3,
  CHANNEL_ID_OBJECT = 4,
  CHANNEL_ZBUFFER = 5,
  CHANNEL_MOTION = 6 ,
  CHANNEL_ROUGHNESS = 7,
  CHANNEL_FRESNEL = 8,
- **Returned Value:** Nothing.

- **Function:** void mergeMxis(stringlist paths, string output);
- **Description:** Merges the given list of MXI files and writes the merged MXI in the given output.
- **Parameters:** stringlist paths: Path of the MXI file. / string output: Path of the merged MXI file.
- **Returned Value:** Nothing.

- **Function:** void startRender(void);
- **Description:** Renders the scene that is currently loaded. The function does not wait until the render finishes.
- **Parameters:** No parameters.
- **Returned Value:** Nothing.

- **Function:** bool isRendering(void);
- **Description:** Returns True if the application is rendering and False if it is not rendering.
- **Parameters:** No parameters.
- **Returned Value:** Bool (True if the application is rendering and False if it is not rendering).

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- **Function:** void print(string text);
- **Description:** Prints the given text in the console.
- **Parameters:** string text: Text to print
- **Returned Value:** Nothing.

- **Function:** bool createAbsoluteFolder (string folderPath);
- **Description:** Creates a folder using the given absolute path.
- **Parameters:** string folderPath: absolute path of the folder to create.
- **Returned Value:** Bool: TRUE if the folder is properly created. FALSE if not.

- **Function:** bool createRelativeFolder (string parentFolder, string folderName);
- **Description:** Creates a folder with the name folderName in the given parent folder.
- **Parameters:**
  - string parentFolder: Absolute path of the parent folder where the folder is going to be created.
  - string folderName: Name of the folder.
- **Returned Value:** Bool: TRUE if the folder is properly. created. FALSE if not.

- **Function:** string getEngineVersion(void);
- **Description:** Returns a string with the version of the engine used.
- **Parameters:** No parameters.
- **Returned Value:** String (engine version).

- **Function:** string getMaxwellFolder(void);
- **Description:** Returns a string with the path of the folder where Maxwell Render is installed.
- **Parameters:** No parameters.
- **Returned Value:** String (path of the Maxwell Render folder).

- **Function:** string getEnv(string var);
- **Description:** Returns a string with the value of the given system environment variable.
- **Parameters:** String var: Environment variable.
- **Returned Value:** String (value of the environment variable).

- **Function:** void flush(void);
- **Description:** Flushes all the pending events in the application. This function can be useful to refresh the GUI elements that are waiting for a pending event (i.e. text printed in console, etc.). Calling this function too often could make the application run significantly slower.
- **Parameters:** Nothing.
- **Returned Value:** Nothing.

- **Function:** string system(string var);
- **Description:** Calls the OS system() function.
- **Parameters:** String var: String given to system().
- **Returned Value:** Nothing.

17.02.02 File Manager

- **Function:** int getNumberOfFilesInFolder(string path, string filter);
- **Description:** Returns the number of files in the given folder that match the filter.
- **Parameters:** String path: Folder to search files / String filter: File filter ("*.*" is allowed).
- **Returned Value:** INT: number of files in the folder that mach the filter.

- **Function:** stringlist getFilesInFolder(string path, string filter);
- **Description:** Returns a list of files in the given folder that match the filter.
- **Parameters:** String path: Folder to search files / String filter: File filter ("*.*" is allowed).
- **Returned Value:** LIST: list of files in the folder that match the filter.

- **Function:** string getFileFolder(string file);
- **Description:** Returns the absolute path of the folder that contains the given file.
- **Parameters:** String file: File path
- **Returned Value:** String path of the folder that contains the given file.

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- **Function:** string getFileName(string file);
- **Description:** Returns the file name of this path. The name does not include the extension.
- **Parameters:** String file: File path
- **Returned Value:** String: name of the file.

- **Function:** string getFileNameAndExtension(string file);
- **Description:** Returns the file name of this path. The name includes the extension.
- **Parameters:** String file: File path
- **Returned Value:** String: name of the file.

- **Function:** INT getNumberOfFilesInBranch(string path, string filter);
- **Description:** Returns the number of files in the folder path and all the subfolders that match the given filter. This function searches recursively until the branch is completed.
- **Parameters:** String path: Path of the folder to search / String filter: Filter to match
- **Returned Value:** INT: Number of files that match the condition.

- **Function:** stringlist getFilesInBranch(string path, string filter);
- **Description:** Returns a list of files in the folder path and all its subfolders that match the given filter. This function searches recursively until the branch is completed.
- **Parameters:** String path: Path of the folder to search / String filter: Filter to match
- **Returned Value:** LIST: List of files that match the condition.

- **Function:** bool copyFile(string origin, string target);
- **Description:** Copies a file from origin to target.
- **Parameters:** String origin: Path of the file to copy / String target: Path of the target file
- **Returned Value:** Bool: returns True if the copy was successful, False if it was unsuccessful.

- **Function:** bool removeFile(string path);
- **Description:** Removes the specified file.
- **Parameters:** String path: Path of the file to remove
- **Returned Value:** Bool: returns True if the file was removed successfully, False if not.

- **Function:** bool renameFile(string path, string name);
- **Description:** Renames the specified file.
- **Parameters:** String path: Path of the file to rename. String name: New name of the file
- **Returned Value:** Bool: returns True if the file was renamed successfully, False if not.

- **Function:** bool createAbsoluteFolder(string path);
- **Description:** Creates a folder.
- **Parameters:** String path: Path of the folder to create
- **Returned Value:** Bool: returns True if the folder was created successfully, False if not.

- **Function:** bool createRelativeFolder(string parentFolder, string folderName);
- **Description:** Creates a folder given a relative path.
- **Parameters:** String parentFolder: Path of the parent folder where the folder will be created. String folderName: Name of the folder
- **Returned Value:** Bool: returns True if the folder was created successfully, False if not.

17.02.03 Multilight

- **Function:** int getLightsCount(void);
- **Description:** Returns the number of lights of the current scene/ MXI loaded.
- **Parameters:** Nothing.
- **Returned Value:** INT: Number of lights.

- **Function:** string getLightName(int index);
- **Description:** Returns the name of the light (emitter material) with the given index.
- **Parameters:** INT index: Index of the light
- **Returned Value:** String: Name of the light.

- **Function:** void refreshLight(int index);
- **Description:** Refresh the light with the given index.
- **Parameters:** INT index: Index of the light
- **Returned Value:** Nothing.

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- **Function:** void refreshAllLights(void);
- **Description:** Refresh all the lights.
- **Parameters:** Nothing.
- **Returned Value:** Nothing.

- **Function:** double getLightIntensity(int index);
- **Description:** Returns the intensity of the light with the given index. The units of the intensity depend on the emitter type (read getLightEmissionType).
- **Parameters:** INT index: Index of the light
- **Returned Value:** Double: Intensity.

- **Function:** void setLightIntensity(int index, double intensity);
- **Description:** Sets the intensity of the light with the given index.
- **Parameters:** INT index: Index of the light / Double intensity: intensity of the light.
- **Returned Value:** Nothing.

- **Function:** int getLightEmissionType(int index);
- **Description:** Returns the emission type of the light with the given index.
  0 = COLOR + LUMINANCE
  1 = TEMPERATURE
  2 = MULTIEMITTER (more than one emitter layer)
  3 = IES
  4 = SKY
  5 = HDRI
- **Parameters:** INT index: Index of the light
- **Returned Value:** INT: Emission type

- **Function:** void setLightEmissionType(int index, int type);
- **Description:** Sets the emission type of the light with the given index. / See getLightEmissionType description.
- **Parameters:** INT index: Index of the light / INT type: emission type
- **Returned Value:** Nothing.

- **Function:** int getLightEmissionColorType(int index);
- **Description:** Returns the emission color type of the light with the given index.
  0 = RGB
  1 = CORRELATED TEMPERATURE
- **Parameters:** INT index: Index of the light
- **Returned Value:** INT: Emission color type

- **Function:** void setLightEmissionColorType(int index, int type);
- **Description:** Sets the emission color type of the light with the given index. / See getLightEmissionColorType description.
- **Parameters:** INT index: Index of the light / INT int: emission color type
- **Returned Value:** Nothing.

- **Function:** nt getLightLuminanceType(int index);
- **Description:** Returns the luminance type of the light with the given index. The luminance type is only used when the emission type is set to
  0 = WATTS + EFFICACY
  1 = LUMENS
  2 = LUX
  3 = CANDELA
  4 = LUMINANCE
- **Parameters:** INT index: Index of the light
- **Returned Value:** INT: Emission luminance type

- **Function:** void setLightLuminanceType(int index, int type);
- **Description:** Sets the emission luminance type of the light with the given index. See getLightLuminanceType description.
- **Parameters:** INT index: Index of the light / INT int: emission luminance type
- **Returned Value:** Nothing.

- **Function:** bool isLightMuted(int index);
- **Description:** Returns whether or not the light with the given index is muted.
- **Parameters:** INT index: Index of the light
- **Returned Value:** Bool: True if the light is muted.

- **Function:** bool isLightSolo(int index);
- **Description:** Returns whether or not the light with the given index is in solo mode.
- **Parameters:** INT index: Index of the light
- **Returned Value:** Bool: True if the light is in solo mode.

- **Function:** bool loadEmixerData (string path);
- **Description:** Loads an emixer file (extension ".emixer") and refreshes the Multilight stage with it.
- **Parameters:** String path: Path of the emixer file to load
- **Returned Value:** Bool: returns True if the file was loaded successfully, False if not.

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- **Function:** bool saveEmixerData (string path);
- **Description:** Saves the current Multilight state in an emixer file (extension ".emixer").
- **Parameters:** String path: Path of the emixer file to save
- **Returned Value:** Bool: returns True if the file was saved successfully, False if not.

17.02.04 MXI

- **Function:** double iso(void);
- **Description:** Returns the current ISO value.
- **Parameters:** Nothing
- **Returned Value:** Double: ISO value.

- **Function:** void setIso(double value);
- **Description:** Sets the ISO value.
- **Parameters:** Double value: New ISO value
- **Returned Value:** Nothing.

- **Function:** double shutter(void);
- **Description:** Returns the current Shutter value.
- **Parameters:** Nothing
- **Returned Value:** Double: shutter value.

- **Function:** void setShutter(double value);
- **Description:** Sets the Shutter value.
- **Parameters:** Double value: New Shutter value
- **Returned Value:** Nothing.

- **Function:** int colorSpace(void);
- **Description:** Returns the 0-index of the color space of the current scene. See the Maxwell Render GUI for more info about available color spaces and their indexes.
- **Parameters:** Nothing
- **Returned Value:** INT: index of color space

- **Function:** void setColorSpace(int value);
- **Description:** Sets the 0-index of the color space of the current scene.
- **Parameters:** INT value: New color space index.
- **Returned Value:** Nothing

- **Function:** double burn(void);
- **Description:** Returns the current burn value.
- **Parameters:** Nothing
- **Returned Value:** Double: burn value.

- **Function:** void setBurn(double value);
- **Description:** Sets the burn value.
- **Parameters:** Double value: New burn value.
- **Returned Value:** Nothing.

- **Function:** double gamma(void);
- **Description:** Returns the current gamma value.
- **Parameters:** Nothing
- **Returned Value:** Double: gamma value.

- **Function:** void setGamma(double value);
- **Description:** Sets the gamma value.
- **Parameters:** Double value: New gamma value.
- **Returned Value:** Nothing

- **Function:** double fStop(void);
- **Description:** Returns the current fStop value.
- **Parameters:** Nothing
- **Returned Value:** Double: fStop value.

- **Function:** void setFStop(double value);
- **Description:** Sets the fStop value.
- **Parameters:** Double value: New fStop value
- **Returned Value:** Nothing

- **Function:** double intensity(void);
- **Description:** Returns the current intensity value.
- **Parameters:** Nothing
- **Returned Value:** Double: intensity value.

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- **Function:** void setIntensity(double value);
- **Description:** Sets the intensity value.
- **Parameters:** Double value: New intensity value.
- **Returned Value:** Nothing

- **Function:** string apertureMap(void);
- **Description:** Returns the current aperture map.
- **Parameters:** Nothing
- **Returned Value:** String: aperture map path.

- **Function:** void setApertureMap(string path);
- **Description:** Sets the aperture map.
- **Parameters:** String path: New aperture map path.
- **Returned Value:** Nothing

- **Function:** string obstacleMap(void);
- **Description:** Returns the current obstacle map.
- **Parameters:** Nothing
- **Returned Value:** String: obstacle map path.

- **Function:** void setObstacleMap(string path);
- **Description:** Sets the obstacle map.
- **Parameters:** String path: New obstacle map path.
- **Returned Value:** Nothing

- **Function:** bool diffractionEnabled(void);
- **Description:** Returns whether diffraction is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if diffraction is enabled, False if it is disabled.

- **Function:** void setDiffractionEnabled(bool state);
- **Description:** Sets diffraction to enabled or disabled.
- **Parameters:** Bool status: New diffraction state.
- **Returned Value:** Nothing

- **Function:** double diffraction(void);
- **Description:** Returns the current diffraction value.
- **Parameters:** Nothing
- **Returned Value:** Double: diffraction value.

- **Function:** void setDiffraction(double value);
- **Description:** Sets the diffraction value.
- **Parameters:** Double value: New diffraction value.
- **Returned Value:** Nothing

- **Function:** double frequency(void);
- **Description:** Returns the current frequency value.
- **Parameters:** Nothing
- **Returned Value:** Double: frequency value.

- **Function:** void setFrequency(double value);
- **Description:** Sets the frequency value.
- **Parameters:** Double value: New frequency value.
- **Returned Value:** Nothing

- **Function:** bool scatteringEnabled(void);
- **Description:** Returns whether scattering is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if scattering is enabled, False if it is disabled.

- **Function:** void setScatteringEnabled(bool state);
- **Description:** Sets scattering to enabled or disabled.
- **Parameters:** Bool status: New scattering state.
- **Returned Value:** Nothing

- **Function:** double scattering(void);
- **Description:** Returns the current scattering value .
- **Parameters:** Nothing
- **Returned Value:** Double: scattering value.

- **Function:** void setScattering(double value);
- **Description:** Sets the scattering value.
- **Parameters:** Double value: New scattering value.
- **Returned Value:** Nothing

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- **Function:** bool vignettingEnabled(void);
- **Description:** Returns whether vignetting is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if vignetting is enabled, False if it is disabled.

- **Function:** void setVignettingEnabled(bool state);
- **Description:** Sets vignetting to enabled or disabled.
- **Parameters:** Bool status: New vignetting state.
- **Returned Value:** Nothing

- **Function:** double vignetting(void);
- **Description:** Returns the current vignetting value.
- **Parameters:** Nothing
- **Returned Value:** Double: vignetting value.

- **Function:** void setVignetting(double value);
- **Description:** Sets the vignetting value.
- **Parameters:** Double value: New vignetting value.
- **Returned Value:** Nothing

- **Function:** void updatePreview(void);
- **Description:** Updates the preview window with the current settings.
- **Parameters:** Nothing
- **Returned Value:** Nothing

- **Function:** void updateDisplay(void);
- **Description:** Updates the main display buffer with the current settings.
- **Parameters:** Nothing
- **Returned Value:** Nothing

17.02.05 Scene

- **Function:** string mxsPath(void);
- **Description:** Returns the current scene path.
- **Parameters:** Nothing
- **Returned Value:** String: scene path

- **Function:** void setMxsPath(string path);
- **Description:** Sets the scene path.
- **Parameters:** String path: New scene path.
- **Returned Value:** Nothing

- **Function:** string imagePath(void);
- **Description:** Returns the current image path.
- **Parameters:** Nothing
- **Returned Value:** String: image path.

- **Function:** void setImagePath(string path);
- **Description:** Sets the image path.
- **Parameters:** String path: New image path.
- **Returned Value:** Nothing

- **Function:** string mxiPath(void);
- **Description:** Returns the current MXI path.
- **Parameters:** Nothing
- **Returned Value:** String: MXI path.

- **Function:** void setMxiPath(string path);
- **Description:** Sets the MXI path.
- **Parameters:** String path: New MXI path.
- **Returned Value:** Nothing

- **Function:** string activeCamera(void);
- **Description:** Returns the camera name of the active camera.
- **Parameters:** Nothing
- **Returned Value:** String: camera name.

- **Function:** void setActiveCamera(string name);
- **Description:** Sets the active camera name.
- **Parameters:** String name: New camera name.
- **Returned Value:** Nothing

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- **Function:** int time(void);
- **Description:** Returns the maximum render time specified for the current scene in minutes.
- **Parameters:** Nothing
- **Returned Value:** INT: time (in minutes).

- **Function:** void setTime(int value);
- **Description:** Sets the maximum render time for the current scene in minutes.
- **Parameters:** INT value: New time value.
- **Returned Value:** Nothing

- **Function:** int samplingLevel(void);
- **Description:** Returns the maximum sampling level for the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: sampling level.

- **Function:** void setSamplingLevel(int value);
- **Description:** Sets the maximum sampling level for the current scene.
- **Parameters:** INT value: New sampling level value.
- **Returned Value:** Nothing

- **Function:** string animationString(void);
- **Description:** Returns the current frame list.
- **Parameters:** Nothing
- **Returned Value:** String: frame list.

- **Function:** void setAnimationString(string frames);
- **Description:** Sets the frame list.
- **Parameters:** String frames: New frame list.
- **Returned Value:** Nothing

- **Function:** bool multilightEnabled(void);
- **Description:** Returns whether Multilight is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if Multilight is enabled, False if it is disabled.

- **Function:** void setMultilightEnabled(bool state);
- **Description:** Sets Multilight to enabled or disabled.
- **Parameters:** Bool status: New Multilight state.
- **Returned Value:** Nothing

- **Function:** int multilightType(void);
- **Description:** Returns the active Multilight type.
  0 = NO MULTILIGHT
  1 = INTENSITY MULTILIGHT
  2 = COLOR MULTILIGHT
- **Parameters:** Nothing
- **Returned Value:** INT: multilightType.

- **Function:** void setMultilightType(double type);
- **Description:** Sets the active Multilight type. See multilightType for more info.
- **Parameters:** Double value: New Multilight type.
- **Returned Value:** Nothing

- **Function:** bool resumeRenderEnabled(void);
- **Description:** Returns whether the resume render flag is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if resume render is enabled, False if it is disabled.

- **Function:** void setResumeRenderEnabled(bool state);
- **Description:** Sets resume render to enabled or disabled.
- **Parameters:** Bool status: New resume render state.
- **Returned Value:** Nothing

- **Function:** int cpuID(void);
- **Description:** Returns the CPU ID for the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: cpu ID

- **Function:** void setCpuThreads(int value);
- **Description:** Sets the CPU ID for the current scene.
- **Parameters:** INT value: New CPU ID.
- **Returned Value:** Nothing

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- **Function:** int cpuThreads(void);
- **Description:** Returns the CPU threads for the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: cpu threads

- **Function:** void setCpuID(int value);
- **Description:** Sets the CPU threads for the current scene.
- **Parameters:** INT value: New CPU threads.
- **Returned Value:** Nothing

- **Function:** int resX(void);
- **Description:** Returns the horizontal resolution for the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: horizontal resolution.

- **Function:** void setResX(int value);
- **Description:** Sets the horizontal resolution for the current scene.
- **Parameters:** INT value: New horizontal resolution.
- **Returned Value:** Nothing

- **Function:** int resY(void);
- **Description:** Returns the vertical resolution for the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: vertical resolution.

- **Function:** void setResY(int value);
- **Description:** Sets the vertical resolution for the current scene.
- **Parameters:** INT value: New vertical resolution.
- **Returned Value:** Nothing

- **Function:** bool lockAspectRatioEnabled(void);
- **Description:** Returns whether the lock aspect ratio flag is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if lock aspect ratio is enabled, False if it is disabled.

- **Function:** void setLockAspectRatioEnabled(bool state);
- **Description:** Sets the lock aspect ratio flag to enabled or disabled.
- **Parameters:** Bool status: New lock aspect ratio state.
- **Returned Value:** Nothing

- **Function:** bool overrideMaterialEnabled(void);
- **Description:** Returns whether the override material flag is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if override material is enabled, False if it is disabled.

- **Function:** void setOverrideMaterialEnabled(bool state);
- **Description:** Sets the override material flag to enabled or disabled.
- **Parameters:** Bool status: New override material state.
- **Returned Value:** Nothing

- **Function:** string overrideMaterialPath(void);
- **Description:** Returns the current override material path.
- **Parameters:** Nothing
- **Returned Value:** String: override material path.

- **Function:** void setOverrideMaterialPath(string path);
- **Description:** Sets the override material path.
- **Parameters: String path:** New override material path.
- **Returned Value:** Nothing

- **Function:** string defaultMaterialPath(void)**;**
- **Description:** Returns the current default material path.
- **Parameters:** Nothing
- **Returned Value:** String: default material path.

- **Function:** void setDefaultMaterialPath(string path);
- **Description:** Sets the default material path.
- **Parameters:** String path: New default material path.
- **Returned Value:** Nothing

- **Function:** string bitmapsDefaultPath(void);
- **Description:** Returns the current bitmaps path.
- **Parameters:** Nothing
- **Returned Value:** String: bitmaps path.

- **Function:** void setBitmapsDefaultPath(string path);
- **Description:** Sets the bitmaps path.
- **Parameters:** String path: New bitmaps path.
- **Returned Value:** Nothing

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- **Function:** int getSceneDependenciesCount(void);
- **Description:** Returns the number of dependencies (external files needed for rendering) of the current scene.
- **Parameters:** Nothing
- **Returned Value:** INT: number of files.

- **Function: stringlist getSceneDependencies(void);**
- **Description:** Returns the paths of all the dependencies (external files needed for rendering) of the current scene.
- **Parameters:** Nothing
- **Returned Value: List:** list of file paths.

- **Function:** bool renderChannelEnabled(void);
- **Description:** Returns whether the render channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the render channel is enabled, False if it is disabled.

- **Function:** void setRenderChannelEnabled(bool state);
- **Description:** Sets the render channel to enabled or disabled.
- **Parameters:** Bool status: New render channel state.
- **Returned Value:** Nothing

- **Function:** bool alphaChannelEnabled(void);
- **Description:** Returns whether the alpha channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True the alpha channel is enabled, False if it is disabled.

- **Function:** void setAlphaChannelEnabled(bool state);
- **Description:** Sets the alpha channel to enabled or disabled.
- **Parameters:** Bool status: New alpha channel state.
- **Returned Value:** Nothing

- **Function:** bool alphaOpaqueChannelEnabled(void);
- **Description:** Returns whether the alpha opaque channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the alpha opaque channel is enabled, False if it is disabled.

- **Function:** void setAlphaOpaqueChannelEnabled(bool state);
- **Description:** Sets the alpha opaque channel to enabled or disabled.
- **Parameters:** Bool status: New alpha opaque channel state.
- **Returned Value:** Nothing

- **Function:** bool shadowChannelEnabled(void);
- **Description:** Returns whether the shadow channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the shadow channel is enabled, False if it is disabled.

- **Function:** void setShadowChannelEnabled(bool state);
- **Description:** Sets the shadow channel to enabled or disabled.
- **Parameters:** Bool status: New shadow channel state.
- **Returned Value:** Nothing

- **Function:** bool materialIDChannelEnabled(void);
- **Description:** Returns whether the material ID channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the material ID channel is enabled, False if it is disabled.

- **Function:** void setMaterialIDChannelEnabled(bool state);
- **Description:** Sets the material ID channel to enabled or disabled.
- **Parameters:** Bool status: New material ID channel state.
- **Returned Value:** Nothing

- **Function:** bool objectIDChannelEnabled(void);
- **Description:** Returns whether the object ID channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the object ID channel is enabled, False if it is disabled.

- **Function:** void setObjectIDChannelEnabled(bool state);
- **Description:** Sets the object ID channel to enabled or disabled.
- **Parameters:** Bool status: New object ID channel state.
- **Returned Value:** Nothing

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- **Function:** bool motionChannelEnabled(void);
- **Description:** Returns whether the motion channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the motion channel is enabled, False if it is disabled.

- **Function:** void setMotionChannelEnabled (bool state);
- **Description:** Sets the motion vector channel to enabled or disabled.
- **Parameters:** Bool status: New motion vector channel state.
- **Returned Value:** Nothing

- **Function:** bool zBufferChannelEnabled(void);
- **Description:** Returns whether the ZBuffer channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the ZBuffer channel is enabled, False if it is disabled.

- **Function:** void setZBufferChannelEnabled(bool state);
- **Description:** Sets the ZBuffer channel to enabled or disabled.
- **Parameters:** Bool status: New ZBuffer channel state.
- **Returned Value:** Nothing

- **Function:** int zBufferMin(void);
- **Description:** Returns the minimum Z depth value of the Z buffer channel.
- **Parameters:** Nothing
- **Returned Value:** INT: minimum Z value.

- **Function:** void setZBufferMin(int value);
- **Description:** Sets the minimum Z depth value of the Z buffer channel.
- **Parameters:** INT value: New minimum Z depth value.
- **Returned Value:** Nothing

- **Function:** int zBufferMax(void);
- **Description:** Returns the maximum Z depth value of the Z buffer channel.
- **Parameters:** Nothing
- **Returned Value:** INT: maximum Z value.

- **Function:** void setZBufferMax(int value);
- **Description:** Sets the maximum Z depth value of the Z buffer channel.
- **Parameters:** INT value: New maximum Z depth value.
- **Returned Value:** Nothing

- **Function:** bool roughnessChannelEnabled(void);
- **Description:** Returns whether the roughness channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the roughness channel is enabled, False if it is disabled.

- **Function:** void setRoughnessChannelEnabled(bool state);
- **Description:** Sets the roughness channel to enabled or disabled.
- **Parameters:** Bool status: New roughness channel state.
- **Returned Value:** Nothing

- **Function:** bool fresnelChannelEnabled(void);
- **Description:** Returns whether the Fresnel channel is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the Fresnel channel is enabled, False if it is disabled.

- **Function:** void setFresnelChannelEnabled(bool state);
- **Description:** Sets the Fresnel channel to enabled or disabled.
- **Parameters:** Bool status: New Fresnel channel state.
- **Returned Value:** Nothing

- **Function:** void setFresnelChannelEnabled(bool state);
- **Description:** Sets the Fresnel channel to enabled or disabled.
- **Parameters:** Bool status: New Fresnel channel state.
- **Returned Value:** Nothing.

- **Function:** bool diffusePassEnabled(void);
- **Description:** Returns whether the diffuse pass is enabled or disabled.
- **Parameters:** Nothing
- **Returned Value:** Bool: True if the diffuse pass is enabled, False if it is disabled.

- **Function:** void setDiffusePassEnabled(bool state);
- **Description:** Sets the diffuse pass to enabled or disabled.
- **Parameters:** Bool status: New diffuse pass state.
- **Returned Value:** Nothing

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- **Function:** int renderChannelType(void);
  0 = DIFFUSE + REFLECTIONS
  1 = DIFFUSE
  2 = REFLECTIONS
- **Description:** Returns the active render type.
- **Parameters:** Nothing
- **Returned Value:** int: Active render type.

- **Function:** void setRenderChannelType(int type);
- **Description:** Sets the render channel type.
- **Parameters:** int type: New render type.
- **Returned Value:** Nothing

17.02.06 Render Events

- **Event:** renderFinished
- **Description:** Event emitted when the render finishes.

- **Event:** samplingLevelChanged
- **Description:** Event emitted when the sampling level changes.

- **Event:** renderError
- **Description:** Event emitted when an error happens during the render.

- **Event:** renderWarning
- **Description:** Event emitted when Maxwell Render emits a warning message during the render.

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17.03 Examples

17.03.01 Render queue example

// This script gets all the MXS files located in the folder "input" and its children
// Opens them, changes their SL and resolution and launches each render
// The output of all the images is stored in the folder "output"
// The script also shows how to handle render events

```
var inputFolder = "C:\input";
var outputFolder = "C:\output";
var engineVersion = Maxwell.getEngineVersion();
var mxsCount =  FileManager.getNumberOfFilesInBranch( inputFolder, "*.mxs" );
var mxsList = FileManager.getFilesInBranch( inputFolder, "*.mxs" );
// Connect event
RenderEvents["renderFinished()"].connect(renderHasFinished);
var i = 0;
var isRendering = 0;
for( i = 0; i < mxsCount; i++ )
{
  renderScene();
  while( 1 )
  {
    if( isRendering == 0 )
    {
        break;
    }
  }
}

////////////////////////////////////////////////////////////////

function renderScene()
```

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```
{
  var mxsFile = mxsList[i];
  var imagePath = outputFolder + "\" + FileManager.getFileName( mxsFile ) + ".png";

  Maxwell.print( "rendering Mxs file: " + mxsFile );
  Maxwell.openMxs( mxsFile );
  Scene.setImagePath( imagePath );
  Scene.setSamplingLevel( 3 );
  Scene.setResX( 256 );
  Scene.setResY( 256 );
  isRendering = 1;
  Maxwell.startRender();
}

////////////////////////////////////////////////////////////////
function renderHasFinished()
{
  isRendering = 0;
  Maxwell.print( "Render finished!!" );
}

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
/////
```

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17.03.02 Multilight example

// This script shows how to use the Multilight API through scripting
// It opens an MXI file, parses all the lights and changes their intensity to 500 Watts

```
Maxwell.openMxi( "C:\multilight_test.mxi" );
var nLights = Multilight.getLightsCount();
for( var i = 0; i < nLights; i++ )
{
  if( Multilight.isLightMuted( i ) == false )
  {
    Multilight.setLightEmissionType( i, 0 ); // Custom emitter
    Multilight.setLightLuminanceType( i, 0 ); // Watts
    Multilight.setLightIntensity( i, 500 );
  }
}

Multilight.refreshAllLights(); // Upload viewers

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
/////
```

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17.03.03 Scene dependencies explample

// This script reads a scene and copies all its dependencies to another location

```
var mxsPath = "C:\scene.mxs";
Maxwell.openMxs( mxsPath );
var nDeps = Scene.getSceneDependenciesCount();
var deps = Scene.getSceneDependencies();
var i;
var targetFolder = "C:\input"
for( i = 0; i < nDeps; i++ )
{
  var currentDep = deps[i];
  var target = targetFolder + "\" + FileManager.getFileNameAndExtension( currentDep );
  Maxwell.print( "Copying dependency: " + currentDep  );
  var ok = FileManager.copy( currentDep, target );
  if( ok == 0 )
  {
    Maxwell.print( "Error copying dependency" );
  }
}
////////////////////////////////////////////////////////////////////////////////////////////////////
```

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17.03.04 Render events example

// This script shows how to register render events within a script

```
var mxsPath = "C:\test_scene.mxs";
var imagePath = "C:\test_render.png";
Maxwell.print( "rendering Mxs file: " + mxsPath );
Maxwell.openMxs( mxsPath );
Scene.setSamplingLevel( 5 );
Scene.setResX( 256 );
Scene.setResY( 256 );
Scene.setImagePath( imagePath );

RenderEvents["renderFinished()"].connect(renderHasFinished);
RenderEvents["samplingLevelChanged(double)"].connect(slHasChanged);
RenderEvents["renderError"].connect(errorHappened);
RenderEvents["renderWarning"].connect(warningHappened);

Maxwell.startRender();

function renderHasFinished()
{
  Maxwell.print( "Render finished!!" );
}

function slHasChanged(sl)
{
  Maxwell.print( "Script Info: SL Changed: " + sl );

  // Copy the current image with this SL to a different location
  var imagePathAtSL = FileManager.getFileFolder( imagePath ) + FileManager.getFileName( imagePath ) + "_sl_" + sl + ".png";
  FileManager.copy( imagePath, imagePathAtSL );
}
function errorHappened(err)
```

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```
{
  Maxwell.print( "Script Info: Render Error: " + err );
}
function warningHappened(warning)
{
  Maxwell.print( "Script Info: Render Warning: " + warning );
}

////////////////////////////////////////////////////////////////////////////////////////////////////
```

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17.03.05 Progressive render for Animations

// This script renders all the MXS files located in the input folder but instead of rendering them sequentially until each one reaches the final SL, it renders them incrementally. First it renders all the frames up to SL 4, producing a low SL version of the whole animation that you can use for starting post-production tasks, and then continues refining the whole animation to SL 6, 8, 10,... in steps of 2 Sampling Levels, until the indicated final SL.

// It is useful for quickly previewing animations, and for overlapping the rendering process with the postproduction process, saving a huge amount of time in animation projects.

```
var inputFolder = "C:\input";
var outputFolder = "C:\output";

var mxsCount =  FileManager.getNumberOfFilesInFolder( inputFolder, "*.mxs" );
var mxsList = FileManager.getFilesInFolder( inputFolder, "*.mxs" );

RenderEvents["renderFinished()"].connect(renderHasFinished);

var initialSL = 4;
var finalSL = 12;
var slStep = 2;
var currentSL = initialSL;

var i = 0;
var isRendering = 0;

while( currentSL <= finalSL )
{
  for( i = 0; i < mxsCount; i++ )
  {
    renderScene();
    while( 1 )
    {
      if( isRendering == 0 )
      {
```

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```
            break;
        }
      }
    }

    currentSL += slStep;
}

////////////////////////////////////////////////////////////////////

function renderScene()
{
    var mxsFile = mxsList[i];
    var imagePath = outputFolder + "\" + FileManager.getFileName( mxsFile ) + ".png";
    var mxiPath = outputFolder + "\" + FileManager.getFileName( mxsFile ) + ".mxi";

    Maxwell.print( "rendering Mxs file: " + mxsFile );

    Maxwell.openMxs( mxsFile );
    Scene.setImagePath( imagePath );
    Scene.setMxiPath( mxiPath );
    Scene.setSamplingLevel( currentSL );
    Scene.setResX( 400 );
    Scene.setResY( 400 );
    Scene.setResumeRenderEnabled( true );

    isRendering = 1;
    Maxwell.startRender();
}

////////////////////////////////////////////////////////////////////

function renderHasFinished()
{
    isRendering = 0;

    Maxwell.print( "Render finished!!" );
}

////////////////////////////////////////////////////////////////////
```

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18 APPENDIX V. GLOSSARY

Abbe: Abbe is related to dispersion - the effect seen when a beam of light passes through a prism and is split up into different wavelengths of light. Abbe controls the amount of dispersion: the higher the Abbe number, the narrower the dispersion will be. If you set the Abbe number really high, the dispersion will disappear completely.

Aliasing: The process by which smooth curves and other lines become jagged because the resolution of the graphics device or the file is not high enough to represent a smooth curve. This problem can be solved with anti-aliasing.

Alpha Blending: The assignment of varying levels of translucency to graphical objects. This allows for the creation of things such as glass, fog, and ghosts. Alpha Blending can be accomplished by using alpha channels, or through other means.

Anisotropic Filtering: Anisotropic Filtering (AF) is a method of enhancing the image quality of textures and surfaces that are far away and steeply angled with respect to the point of view. Older techniques don't take account of the angle that the surface is viewed from, which can result in aliasing or blurring textures. By reducing detail in one direction more than another, these effects can be reduced.

Anisotropy: The property of being directionally dependent, as opposed to isotropic, which means homogeneity in all directions. An anisotropic surface will change in appearance as it is rotated around its geometric normal, like with velvet. In Maxwell Render the Anisotropic material setting will create a material that is more reflective in one direction, and more diffuse in the perpendicular direction. In real life this is caused by polishing a surface in one dominant direction, making small grooves on the surface which run mostly in one direction.

Anti-Aliasing: This is the process that removes the aliasing effect. A filtering method is normally used in the process that removes the "jaggedness effect" produced by pixels. (Also see Aliasing).

Aperture: An aperture is a hole or opening through which light is admitted. In photography, the aperture size of the lens can be adjusted to control the amount of light reaching the film. A diaphragm usually serves as an aperture stop and controls the aperture.

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Attenuation distance: Attenuation is the reduction in amplitude and intensity of a signal. As light travels through a material, it loses energy. The Attenuation distance parameter in Maxwell Render allows you to specify how far light can move through an object before losing half its energy. For example, if you have a 2 cm thick glass window, and you set the Attenuation distance to 2 cm, the light shining through the glass on the other side will be half as bright.

BSDF: BSDF, or Bidirectional Scattering Distribution Function, is a set of mathematical functions that describe how light interacts with a material. These functions can describe opaque, transparent and translucent materials and their surface properties such as roughness, color etc.

Burn: An image is burned when its contrast is raised too much, and it results in the image containing uniform blobs of color, black, or white where there actually should be detail. In Maxwell Render, Burn is a tone-mapping parameter that controls how fast the image is over-exposed.

Camera Frustum: Generally, the field of view of the camera. The Camera Frustum in Maxwell Render is indicated by a yellow frame. Anything inside this frame will be rendered.

Channels: Rendering information can be stored separately in different images or channels, and this is usually done for compositing purposes. Maxwell Render can split the information obtained during the rendering process and produce independent Shadow channels, Alpha channels, Material Id channels, Object Id channels, Z-buffer channels, Motion Vector channels, Diffuse channels, and Reflection channel, as well as the complete composed image.

Clip map: A texture with completely black or completely white pixels only. It can be used in Maxwell Render as a Layer weight to determine which parts of a material should be made visible (white areas) or invisible (black areas).

Depth of Field: Depth of Field, or DOF, is the area in front and beyond the camera focal distance (the camera target) where the objects will appear in focus. The camera parameters that affect the DOF the most are the f-Stop and focal length settings. Other variables such as film width/ height and distance of the camera to the subject will also affect the DOF.

Diaphragm: In photography, a diaphragm is a thin opaque structure with an opening (aperture) at its center. The role of the diaphragm is to stop the passage of light, except for the light passing through the aperture. The diaphragm is placed in the light path of a lens or objective, and the size of the aperture regulates the amount of light that passes through the lens. Its diameter is controlled by the f-Stop parameter. The smaller the f-Stop value, the bigger the diaphragm opening, and viceversa.

Diffraction: This is an effect that happens when light goes through small holes, causing interference patterns. All lenses exhibit diffraction, especially when the camera lens is pointing straight at a strong light source such as the sun. Diffraction is also known as glare.

Diffuse: The reflection of light from an uneven or granular surface, resulting in an incoming light wave being reflected at a number of angles. Diffuse reflection is the opposite of specular reflection. It is the difference between glossy (specular) and matte (diffuse) paints.

Dispersion: The effect seen when a beam of light passes through a prism and is split up into different wavelengths of light.

Efficacy: Refers to the amount of light produced by a light source, usually measured in lumens. Efficacy specifies how many lumens are emitted per watt and thus how efficiently electricity is converted into visible light.

Emitter: In Maxwell Render, "emitter" refers to geometry that has an emitter material applied to it.

Focal length: The focal length of a lens refers to the distance between the lens itself and its focal point (where the light will be focused, usually where the film is). The focal length of a lens determines the field of view (FOV), or how much you see of your scene, and also the DOF. A small focal length lens (15-24mm) is said to be a wide-angle lens because it captures a lot of the scene (it has a wide FOV), and its DOF is wide (almost all the objects in the scene will be in focus). A large focal length lens (80-200mm) is said to be a telephoto lens as it acts like a binocular, "zooming" in to a particular area of your scene (it has a small FOV) and the DOF will be very narrow (only a small portion of your scene will be in focus).

FPS: An abbreviation for "frames per second".

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Fresnel Effect: The apparent increase/ decrease of a surface's reflectance based on viewing angle. The Fresnel effect is dependent on the IOR of the material. The higher the IOR, the more reflective a material becomes at all angles. This means the Fresnel effect diminishes because the material becomes equally reflective at all angles. The effect has been named after the French physicist who described it.

f-Stop: An important notion in optics, f-Stop expresses the diameter of the diaphragm of the lens in terms of the effective focal length of the lens. f-Stop is the quantitative measure of lens speed in photography. The smaller the f-Stop, the bigger the diaphragm opening (aperture) of the lens is, allowing more light in and making the DOF narrower, meaning only a small area of the image will be in focus.

GMT: Refers to "Greenwich Mean Time", generally used as a universal time zone.

IBL: Stands for Image Based Lighting. You can light your scene with a high dynamic range image (HDR, MXI, EXR). The image used should be in a longitude-latitude format to work correctly in Maxwell Render. It will be mapped to a virtual sphere that encompasses your scene. IBL images recreate lighting from real-world light sources to create realistic lighting environments.

Illuminance: Illuminance is specified in lux, which is defined as one lumen per square meter. It is a useful setting in Maxwell Render if you want to increase/ decrease the size of an emitter, and have it emit more or less light with the changed size of the emitter. For example, if an amount of light is emitted over a larger area, it will give the impression that the light is weaker.

IOR (complex/full): IOR stands for "Index Of Refraction" and is a measure of how much the speed of light is reduced as it passes from a vacuum into a material. Complex or full IOR data are collected from precise measurements in laboratories and describe the optical properties of a material to the highest degree of accuracy. These materials are extremely realistic.

ISO: Film ISO, or film speed, is the measure of a photographic film's sensitivity to light. The lower the ISO, the lower the film's sensitivity, requiring a longer exposure, while a film with a high ISO needs only a short exposure to light.

Lambertian: Lambertian reflectance means that light falling on a surface is scattered in such a way that the apparent brightness of the surface is the same, regardless of the observer's angle of view. In other words: the surface's luminance is the same regardless of angle of view. Many rough surfaces, such as unfinished wood, exhibit Lambertian reflectance. In Maxwell Render, Lambertian behavior is seen when Roughness is set to 100.

Latitude: Describes a location north or south of the equator. Technically, it is an angular measurement in degrees ranging from 0 degrees at the equator, to 90 degrees at the poles. Latitude can be combined with longitude to give a precise position on the Earth's surface.

Longitude: Describes a location east or west of a north-south line called the Prime Meridian. Longitude is given as an angular measurement ranging from 0 degrees at the Prime Meridian to +180 degrees eastward and -180 degrees westward. Longitude and latitude together can point to a specific location on the Earth's surface.

Lumens: Lumens (lm) is the SI unit for luminous flux. It is a common way to specify how much light is emitted. Light manufacturers usually supply this data.

Luminous intensity: Luminous intensity is the power of light emitted in a certain direction, and it is specified in candela (cd).

Maxwell.exe: Previously known as MXCL, it is the core rendering application. Whether you launch your render via the plug-in from your 3D platform or from Studio, Maxwell.exe is the application that performs the actual rendering. Maxwell.exe also provides tools for image editing, Multilight controls, scripting features, etc.

Motion blur: The apparent streaking of rapidly moving objects in a still image or a sequence of images such as a movie. When a camera creates an image, that image does not represent a single instant of time, but a series of instants over a period of time. As objects in a scene move, an image of that scene must represent an integration of all positions of those objects, over the period of exposure determined by the shutter speed (or shutter angle in the case of an animation). In such an image, an object moving with respect to the camera will look blurred or smeared along the direction of the relative motion.

Multilight: Multilight™ is a special feature of Maxwell Render that allows the user to change intensities of individual lights in the scene during and after the rendering process. This feature is the first of its kind in a commercial render engine and it is extremely

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powerful allowing you to produce many different lighting combinations from just one render.

MXCL: Refers to the Maxwell render engine, which is command line controllable. Users can connect to MXCL via one of the supported plug-ins or through Studio.

MXED: Stands for "Maxwell Material Editor". It is a standalone material editor within the Maxwell Render software, with powerful, layered, physical materials and a material browser.

MXI: Stands for "Maxwell Image". It is Maxwell Render's high dynamic image format which stores all the lighting calculations. This powerful image format allows for resume render and Multilight adjustments.

MXI/HDR: (Maxwell Render parameter) This option allows us to light the scene with a HDR or MXI map. In this box there is an option for selecting the type of lighting for the channels that are disabled. With this option you can, for example, insert a background into your image if you apply the map in background textured.

MXM: Stands for "Maxwell Material". It is the Maxwell material format.

MXS: Stands for "Maxwell Scene". It is the Maxwell Render scene format.

MXST: Stands for "Maxwell Studio". It is an independent application within the core components of Maxwell Render. MXST allows users to import objects in different formats, create/ edit/ apply materials, and set up lights and textures. MXST can then send the scene to MXCL to be rendered. MXST is not a modelling application.

Offset: An integer indicating the distance from the beginning of an object up until a given element or point, presumably within the same object.

OpenGL: OpenGL stands for Open Graphics Library and is a standard specification defining a cross-language, cross-platform API for writing applications that display 2D and 3D computer graphics. Graphics cards that take advantage of this library will speed up the display of 3D objects in the viewport.

Physical sky: Simulates the physical sky in an image for any time of day, any day of the year.

Polygon: A polygon is a closed plane which is bound by three or more line segments. A triangle polygon has three sides; a "Quad" had four sides and an "N-gon" can have more than four sides. Maxwell Render transforms all types of polygons into triangles when rendering.

RGB: Stands for "red, green, blue". Red, green and blue are the 3 colors that are used by monitors to display images. They are called additive colors because the more of each RGB color is added, the brighter the resultant color. 100% of RGB will produce white.

Scattering: Lens Scattering, more commonly known as bloom, is caused by the imperfect focus of a lens, causing light scattering inside the lens before it reaches the film. This produces artifacts of fringes of light around very bright objects in an image, making is seem as if the image of the bright light bleeds beyond its natural borders.

SDK: Short for Software Development Kit, used by developers to create their own Maxwell Render plug-ins or applications.

Shutter: In photography, a shutter is a device that allows light to pass for a determined period of time to expose photographic film to the right amount of light to create an image. The shutterspeed is usually denoted in hundreds of a second, for example 1/100, which will keep the shutter open for one hundredth of a second.

Shutter angle: Film cameras use a rotating disc with an adjustable pie-shaped cut-out in it, which controls how long each frame is exposed. The width of the cut-out is called the shutter angle, and is expressed in degrees. The shutter angle controls the amount of motion blur in animations. Fully open (180 degrees) will yield the maximum amount of motion blur, while a very narrow setting (say, 15 degrees) will produce very subtle motion blur. In the Maxwell camera settings, the shutter angle you set automatically translates your usual ISO/ Shutter speed settings in combination with the shutter angle, so your animation exposure will match your still image exposure, while producing the proper amount of motion blur.

SimuLens: A collection of lens effects that mimic how a real optical device interacts with light. These effects include lens scattering, vignetting and diffraction. These effects are a post-process that can be applied to a render inside Maxwell Render.

Sky Dome: This is a virtual dome which encompasses your entire scene and can be used for uniform lighting. You can choose the color of the sky dome.

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SL: Stands for Sampling Level. In Maxwell Render, this value controls the quality of the render. The higher the sampling level reached, the more accurate the image.

Specular: Specular reflection is the perfect, mirror-like reflection of light from a surface, in which light from a single incoming direction is reflected into a single outgoing reflection, for example with a mirror. Specular reflection is the opposite of diffuse reflection.

SSS: Stands for sub-surface scattering, an effect whereby light penetrates the surface of a translucent object, is scattered by interacting with the material under the surface, and exits the surface at a different point. Inside Maxwell Render, SSS is important for the realistic rendering of for example marble, skin and milk.

Studio: Previously known as Maxwell Studio or MXST. It is an independent application within the core components of Maxwell Render. Studio allows users to import objects in different formats, create/ edit/ apply materials, and set up lights and textures. Studio can then send the scene to Maxwell.exe to be rendered. Studio is not a modeling application and needs existing geometry to work with.

Turbidity: Turbidity is a cloudiness or haziness of water (or other fluids) caused by individual particles that are generally invisible to the naked eye.

Unbiased Rendering: The method of rendering which, contrary to biased rendering, does not use interpolation or guessing of the samples taken to render the image. Unbiased rendering avoids the typical interpolation and aliasing artifacts associated with biased rendering. This is the method of rendering used in Maxwell Render.

Vertex: In geometry, a vertex is a point formed by the intersection of the segments of the object: a vertex of a polygon is the point of intersection of two polygon edges. Plural: vertices.

Vignetting: In photography and optics, vignetting is a reduction in image brightness in the image periphery compared to the image centre. It can be controlled using Maxwell Render's SimuLens parameters. Wide-angle lenses (with a focal length of around 24mm) will produce more vignetting compared to larger focal length lenses. After a certain focal length (around 80mm) the vignetting effect is no longer noticeable.

Watts: The Watt is the SI derived unit of power, equal to one joule per second. Watts specifies how much electricity a light source consumes.

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